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NATIONAL GEOGRAPHIC

A close-up, front-facing view of a stealth fighter jet's cockpit. The canopy is dark and reflective, showing the pilot's helmet and oxygen mask. The jet's nose is pointed directly at the viewer, and the wings are visible on either side. The background is a blurred outdoor setting.

The Future of **Flying** *Faster, Farther, Smarter*

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PLUS Commemorative Map: 100 Years of Flight

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BE MADE OF SHEET METAL?



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NIGHT VISION. ALLOW US TO SHED SOME LIGHT.

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*OnStar services require vehicle electrical system and analog wireless service to be available and operating for features to function properly. Visit www.onstar.com for system information and details. **Testing conducted by the National Highway Traffic Safety Administration (NHTSA) as part of its New Car Assessment Program (NCAP).



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▲ Scott Takeda/Writer

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THE COVER

The Air Force's new supersonic stealth fighter, the F/A-22 Raptor, will soon patrol the skies.

BY JOE McNALLY

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ON THE NGM WEBSITE

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MONDAYS, 8 P.M. ET/9 P.M. PT

Worlds Apart

What happens when a family from a New York City suburb gets dropped into a village in India for nine days? The shock almost sent the Rappy family fleeing home. Sacrificing a goat for much needed rain and tilling a field with a camel taxed the Americans. But when a downpour turned into a joyous mud fight, barriers fell. In this episode of

the new series *Worlds Apart*, Floyd Rappy, at right, creates a bond with the host family of Mehendra Rathore, including a great uncle, at left, that will change the lives of their families forever.

SUNDAYS, 8 P.M. ET/PT

Kratt Brothers: Be the Creature

Crawl, swim, and waddle with elephant seals (right), killer whales, and penguins on the shores of Patagonia—one of many upcoming wild adventures with award-winning filmmakers Martin and Chris Kratt. Their new *Be the Creature* series gets you inside the extraordinary lives of wild animals.



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DECEMBER 15-19

8 P.M. ET/9 P.M. PT

Flight Nights

To celebrate the 100th anniversary of the Wright brothers' achievement, the Channel presents *5 Nights of Flight: Test Pilots, Air Force One, High Flyers* (amateur aviators), *The Rocket Ranch* (those who maintain the space shuttle), and *Charles Lindbergh*.

Channel and NGT&F programming information accurate at press time; consult local listings or the Society's website at nationalgeographic.com

NG Television & Film



NATIONAL GEOGRAPHIC
ULTIMATE EXPLORER, MSNBC
PREMIERES IN DECEMBER

Chasing the American Dream

Desperate for a better life, illegal immigrants from Mexico and Central America daily attempt to cross the U.S. border. Host Lisa Ling explores the risks they take and the struggles they face in their new home.

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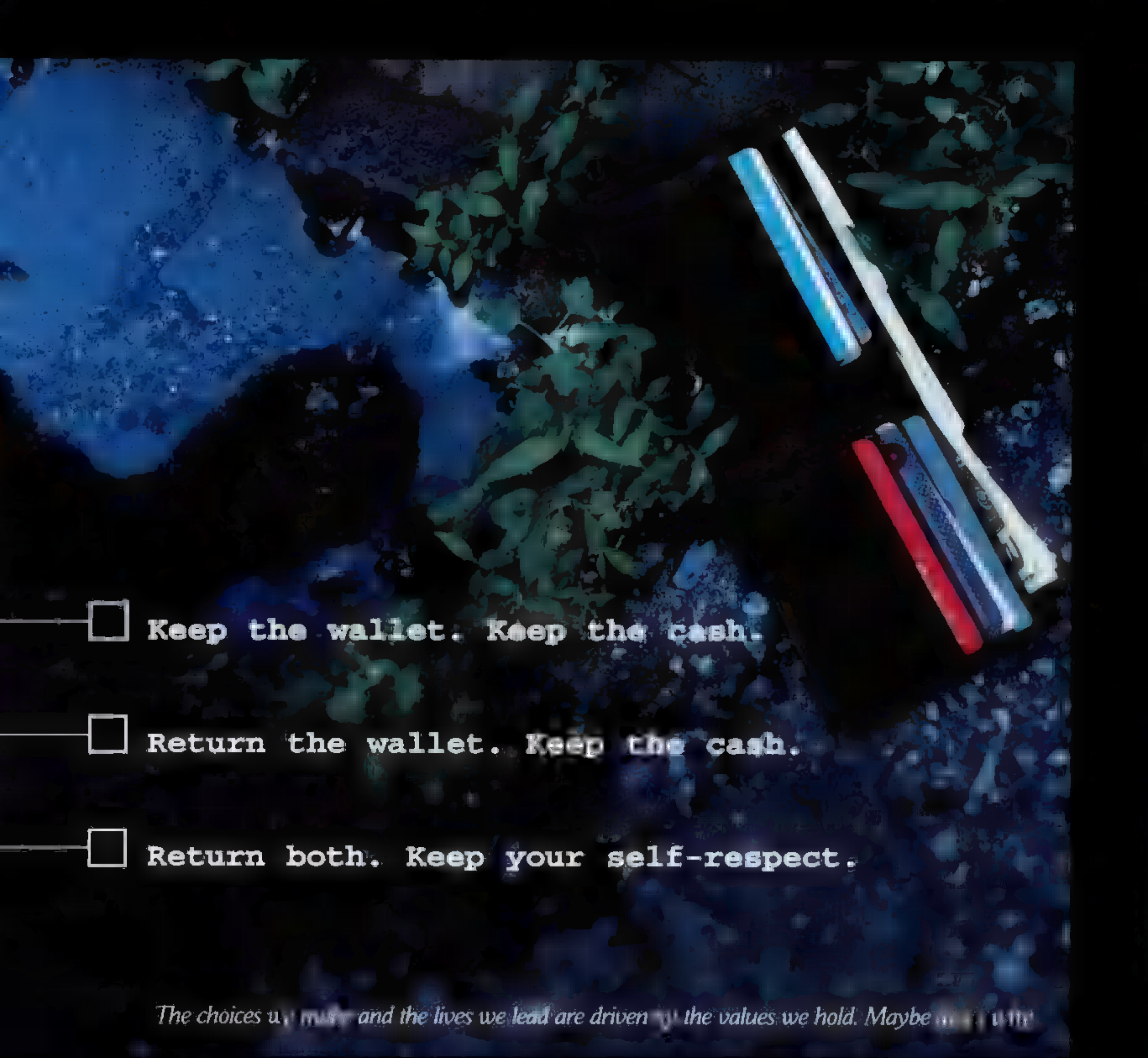
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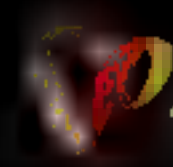
AOL Keyword NatGeo

- 
- Keep the wallet. Keep the cash.**
 - Return the wallet. Keep the cash.**
 - Return both. Keep your self-respect.**

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Talk about a bird's-eye view: I recently soared over Virginia's Shenandoah Valley in a sailplane, sharing the sky with circling turkey vultures.

Aviators have learned a lot by imitating birds. Sailplane pilots, for example, ride columns of rising warm air to gain altitude, much as birds do. The first successful controlled, powered flight—milestone whose centennial we celebrate this month—also shared some similarities to the flight of birds. The wings of the

Wright brothers' Flyer functioned a lot like a turkey vulture's—one wing twisting up and the other down, just as a vulture angles its wings when it soars.

Of course, airplanes have changed dramatically since the Wrights. The pilot of the Flyer manipulated its wings by moving his hips; now many aircraft have computers that

automatically make split-second adjustments to wing shape.

And just as the Wrights couldn't have imagined the technological innovations of today's planes, it's not easy for us to imagine the planes of the future. Many revolutionary aircraft are being developed as military projects. That's why I'm inviting you to turn to page 2. Thanks to the hard work of the NATIONAL GEOGRAPHIC staff, this month's cover story turns imagination into reality as it shows you: What's next in the air.

Bill Allen

WILLIAM L. ALLEN: RETNA; SHENANDOAH VALLEY: NICK HENNING/AMERICAN; ALI: NGS (TOP); NGS PHOTOGRAPHER JODI COBB (BOTTOM)

EMERGING EXPLORER JIMMY CHIN Whether climbing and photographing on Mount Everest's treacherous North Face, following endangered antelope across a grueling Tibetan plateau, or achieving first ascents of giant granite towers in Pakistan's Karakoram Mountains, Jimmy Chin is all about going to extremes. His passion for exploration and photography takes him around the world on breakthrough expeditions. Using his unique blend of physical and technical skills, Jimmy and his camera find their way into the places, conditions, and moments few others can capture.



Taking discovery to new heights



"I THRIVE ON THE CHALLENGE OF FACING THE UNKNOWN. Exploring some of the world's most remote places inspires me. But my true goal isn't just reaching these places. Through exploration, photography, and immersing myself in cultures far from home, I hope to expand awareness of our beautiful planet... our responsibility to conserve and protect it... and offer a new perspective on our own culture and who we are."

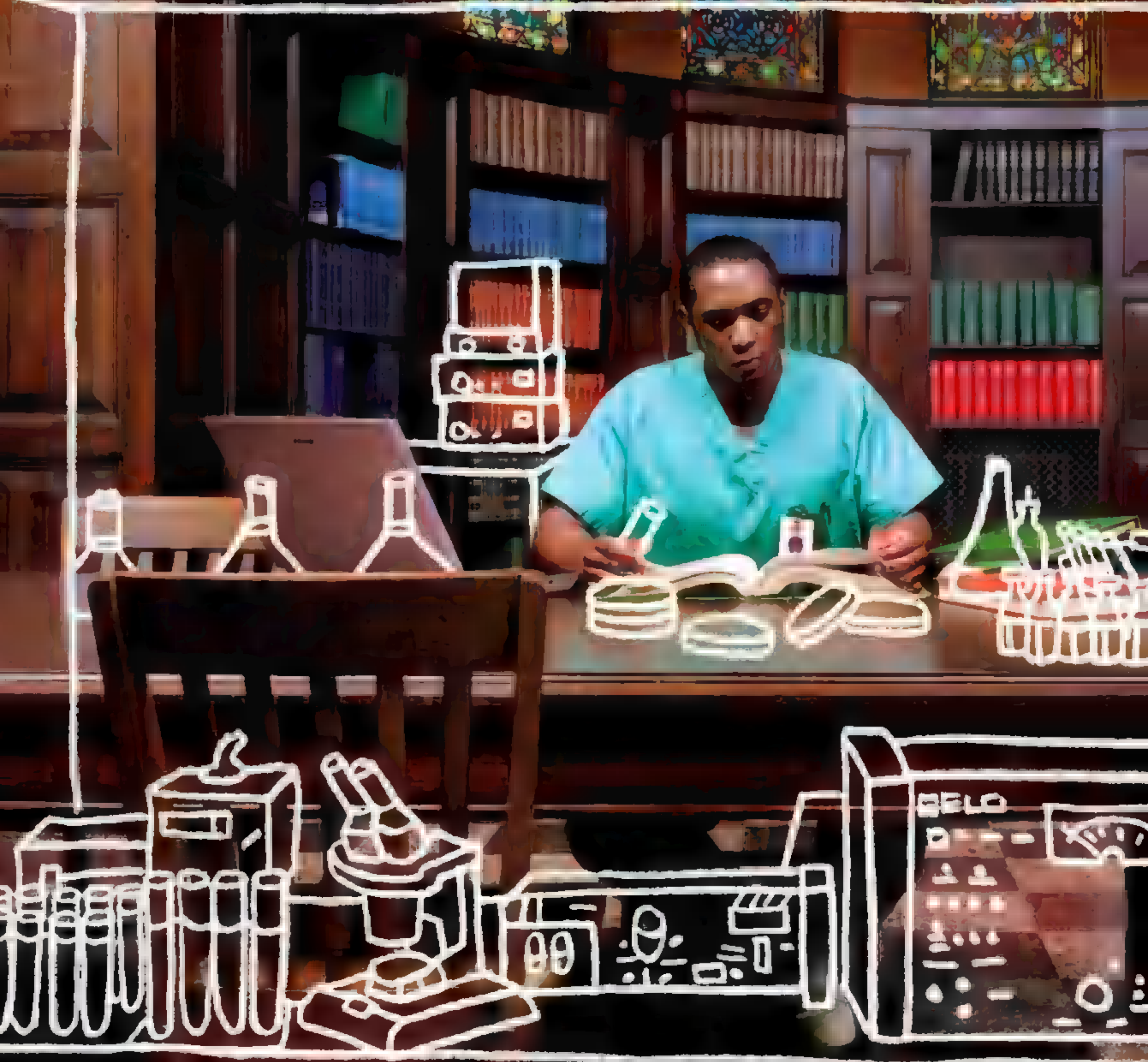
Jimmy Chin, Climber, Photographer

Around the world, National Geographic Society has identified Emerging Explorer Program grantees who push the boundaries of discovery.

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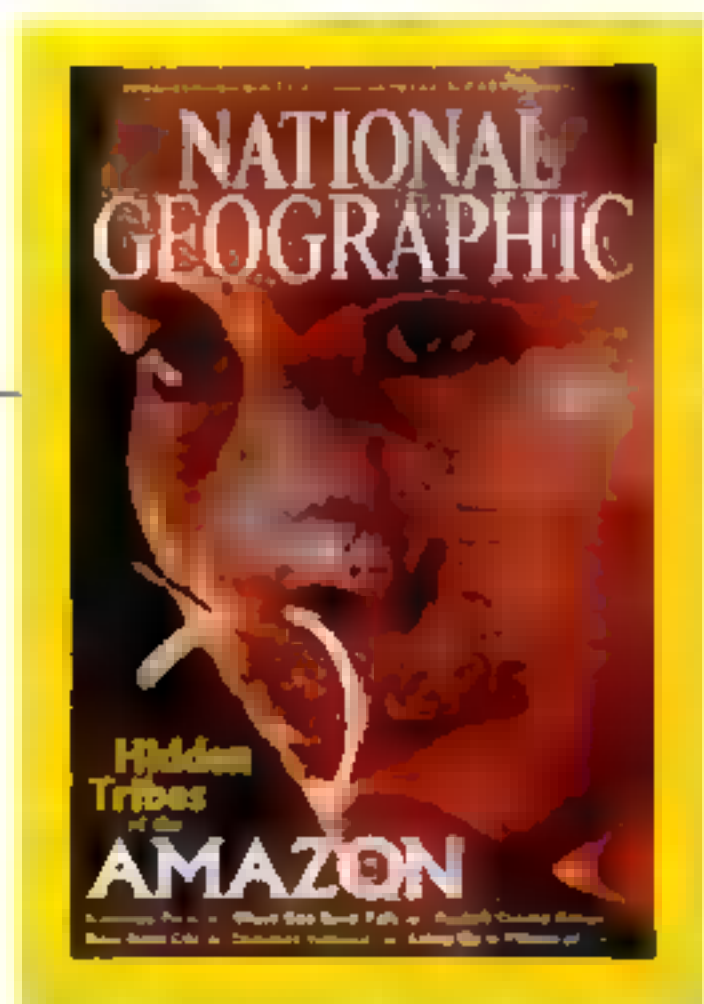
Your potential. Our passion.

Forum

August 2003

The story on Sydney Possuelo's quest to protect isolated Amazonian Indians from contact with the outside world generated the most mail. Is Possuelo a hero or a misguided romantic? The spirited argument spilled over onto our website's Forum (nationalgeographic.com/ngm/0308).

An online poll asked, "Should isolated, uncontacted peoples be left alone?" Almost two-thirds said yes.



Into the Amazon

I am surprised there are still tribes like the Flecheiros able to avoid the onslaught of our so-called civilization. We have wiped out so much knowledge of the first people to populate North and South America. The Flecheiros live in harmony with nature and don't need interference or salvation. Their Garden of Eden should be spared.

JAMES O. YOUNG
Represa, California

Having lived with isolated tribal populations throughout Amazonia since 1966, I take exception to the quote attributed to Sydney Possuelo: "Uncontacted Indians live in a lost paradise." Not exactly. It is often a brutal world of lives cut short by disease and homicide from intertribal warfare. Ask the Indians of Ecuador and Peru if they wish to go back to the days before the introduction

of modern medicine and the end of revenge killings. Cultural change is inevitable. To think otherwise is misguided romanticism.

JOHN WALDEN, M.D.
Huntington, West Virginia

Is the life of the Indians tough? By our standards, yes. But I bet they could survive forever if just left alone. What about us, the "educated" and "civilized" people? We are the ones who need to be saved, not them.

OCTAVIO CAMPOS SALLES
São Paulo, Brazil

Supposedly, isolated Amazon tribes are protected from outside contact for their own good. But who are we to choose what is good for another group of people? Through the vigorous "protection" espoused in the article, they are being denied choice, and by being denied choice, they are being denied their humanity. They are being treated like endangered animals, all for the sake of someone else's sense of wild beauty.

JENNY TENNANT
Morgantown, West Virginia

I appreciated Sydney Possuelo's decision to let the uncontacted



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Zimbabwe

The forced removal by Robert Mugabe's government of white farmers, black farmworkers, and their families from commercial farms—and the consequent destruction of Zimbabwe's economy, bringing about poverty, misery, and mass starvation is a crime against humanity. Inaction on the part of regional African governments (especially South Africa's), as well as governments around the world, is a moral outrage.

JULIAN MISIEWICZ
Oxford, England

Is the Mugabe regime justified in dispossessing white farmers of their land in Zimbabwe? Ponder these scenarios: Should

Australians relinquish their land to the Aborigines? And New Zealanders their land to the Maori? And what of white farmers in the U.S. who took land from Native Americans? More to the point, should the blacks in Zimbabwe surrender their land to the Bushmen, the region's original inhabitants? Today's Zimbabwean white farmer is not responsible for what happened a hundred years ago.

STAN MITCHELL
Borger, Texas

President Mugabe and the millions of blacks in Zimbabwe are not to be blamed if their country goes hungry as a result of land reform. The arrival of the whites in the late 19th cen-



GIDEON MENDEL

tury started the natives' miseries. True, most of the blacks don't have experience in farming as the whites do, but isn't that because they have long forgotten the trade after the white colonizers dispossessed them?

ARNOLD CARL F. SANCOVER
Cebu City, Philippines

In an attempt to be fair, your article created a rationalization for Mugabe's pogroms. He has no interest in redressing past imbalances. On the contrary, his only interest is in holding on to power.

BRENDAN MCKENNA
Dublin, Ireland



tribes live as they have lived for hundreds, maybe thousands of years. It's the choice of the Flecheiros and theirs alone to take the first step toward us—if they want to know us. Thank you for opening a window to an Earth still wild, still untamed.

JENNY FRIEDL
Pfarrkirchen, Germany

Perhaps some of the Flecheiros would prefer something different from squatting around a fire and eating, as the article's author, Scott Wallace, describes in On

Assignment, "tough" monkey meat in a "stinky" broth. Modern civilization has its benefits.

VIVIAN LEE ELLINGSON
Apache Junction, Arizona

I am quite sure that the Flecheiros can come out and look for us if they want to. We should learn a lesson from what happened to Australia's Aborigines and New Zealand's Maori! After contact, the Flecheiros will be abandoned. Leave them alone.

MARIUCCIA ALCOCK
Ipswich, England

their culture is so radically different from mine, their traditions seem savage and brutish when viewed through the moral lens of modern Christianity. It might be humbling to consider that only a few hundred years ago Christians were burning people alive because they thought they were witches.

JUAN CASERO
Hialeah, Florida

The article focused on Sydney Possuelo's mission to protect the Flecheiros, one of the few remaining uncontacted tribes in the world, and it noted that outsiders can have (and have had) devastating effects on such populations. By publishing the article in your widely read magazine, including a map showing the location of the tribe, NATIONAL GEOGRAPHIC has

WRITE TO FORUM

National Geographic Magazine, PO Box 98199, Washington, DC 20090-8199, or by fax to 202-828-5460, or via the Internet to ngsforum@nationalgeographic.com. Include name, address, and daytime telephone. Letters may be edited for clarity and length.

What disturbed me the most about the short sidebar story, "After First Contact," was the Korubo's practice of infanticide. Then I realized that my Christian values were clouding my ability to objectively draw conclusions about these people. Because



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To enter the Sweepstakes without making a purchase, hand print your name, complete mailing address, telephone number, age, & the first six digits of your MasterCard account number on a plain 3" x 5" piece of paper & mail it in a sealed envelope to: MasterCard Holiday Trip-A-Day Giveaway, P.O. Box 14013, Bridgeport, CT 06673-4013. Enter as often as you wish by mail, but each entry must be mailed separately to be received by 1/7/04. No photocopied, computer generated facsimiles, mechanically reproduced, or mass entries permitted. Your use of your MasterCard card to make a purchase and/or your submission of a mail-in entry constitutes your consent to participate in this Sweepstakes & your consent for Sponsor to obtain, use, & transfer your name, address & other information for the purpose of administering this Sweepstakes. 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Sponsor reserves the right, in its sole discretion, to void any & all entries of an entrant who Sponsor believes has attempted to tamper with or impair the administration, security, fairness, or proper play of this Sweepstakes. **Prizes:** 1.) **Grand Prize:** A 5-day/4-night trip to Universal Orlando Resort in Orlando, FL for the winner & up to three (3) guests consisting of round-trip coach air transportation from a major U.S. airport near winner's residence, four (4) nights lodging at the Royal Pacific Resort (two double-occupancy rooms, including room & room tax charges only), a total of four (4), five-day admission passes to Universal Studios Florida & Universal Islands of Adventure, a total of four (4), four-night Universal CityWalk Orlando Party Passes, round-trip ground transportation to/from the airport & the hotel, & a \$2,500 MasterCard Gift Card which may be used toward spending money (collectively the "5-day/4-night Universal Orlando Resort Trip Package") (Approximate Retail Value "ARV"=\$7,848) (61) **Daily Prizes/One Prize Per Day:** The 5-day/4-night Universal Orlando Resort Trip Package (ARV=\$7,848) Total ARV of all prizes: \$486,576. Prizes will be awarded in drawings as outlined below. Travel arrangements must be made a minimum of sixty (60) days prior to date of departure & are subject to availability. Blackout dates & other travel/accommodation restrictions may apply. Winners will be responsible for meals, insurance, incidentals, gratuities, ground transportation other than that described above & for any other expenses not specifically stated herein. Trip must be completed by 12/31/04 or prize will be forfeited in its entirety. Winners & their respective traveling companions will be required to travel together on the same itinerary, & minor traveling companions (if any) must be accompanied by a parent or legal guardian. MasterCard Gift Cards will expire one year from the date of issuance & other restrictions may apply. Federal, state, & local taxes & all other expenses not specified herein are winners' sole responsibility. **Winner Selection:** Grand & Daily Prize drawings will be conducted on/about 1/30/04. Grand Prize winner will be selected in a random drawing from among all eligible entries received during the Promotion Period. Daily Prize winners will be selected in a total of sixty-one (61) individual random Daily Prize drawings (one for each day of the Promotion Period). Each Daily Prize drawing will be held from among all eligible MasterCard card purchases made on that respective day & all mail-in entries received on the 7th day following said day of the Promotion Period. For example, eligible MasterCard card purchases made on 12/2/03 & mail-in entries received on 12/9/03 will be included in the 12/2/03 Daily Prize drawing. As mail is not received by PST on Saturdays & Sundays, mail received on Mondays will be entered into the applicable Saturday, Sunday & Monday Daily Prize drawings to determine each respective Daily Prize winner. For example, eligible mail-in entries received on Monday, 12/15/03, will be included in the 12/6/03, 12/7/03 & 12/8/03 Daily Prize drawings. A total of three (3) legal holidays with no mail delivery occur during the Promotion Period: For Veterans' Day, 11/11/03, mail received on 11/12/03 will be included in both the 11/4/03 & 11/5/03 Daily Prize drawings; For Thanksgiving, 11/27/03, mail received on 11/28/03 will be included in both the 11/20/03 & 11/21/03 Daily Prize drawings; & for Christmas, 12/25/03, mail received on 12/26/03 will be included in both the 12/18/03 & 12/19/03 Daily Prize drawings. Entries received for one Daily Prize drawing will not carry forward to subsequent Daily Prize drawings but will be included in the Grand Prize drawing. All drawings will be conducted by PST, an independent judging organization whose decisions are final & binding in all matters relating to this Sweepstakes. Prizes will be awarded to the primary (as determined by the MasterCard member financial institution's account records) account holder named on the account accessed by the MasterCard card used to make the entry or referenced on the mail-in entry. In the event a winning account selected is a corporate MasterCard card account, prize will be awarded to the individual named on the MasterCard card that is used to transact the winning entry (as determined by the MasterCard member financial institution's account records) & if awarding of prize is in conflict with corporate written policy, prize will be forfeited & an alternate winner will be selected. Winners will be notified by telephone and/or mail. Odds of winning any prize will depend on the number of eligible entries received for the applicable drawing. Limit one prize per person, immediate family member, or household. **Miscellaneous:** No transfer, assignment, cash redemption, or substitution of prize (or portion thereof) except by Sponsor due to prize unavailability, & then for a prize (or applicable portion thereof) of equal or greater value. Winners will be required to execute & return an Affidavit of Eligibility, Liability Release & (where legal) Publicity Release within five (5) days of issuance of notification. Traveling companions (if a minor, their respective parent or legal guardian) will be required to sign & return a Liability Release & (where legal) Publicity Release prior to the issuance of travel documents. Non-compliance with any of the foregoing may result in disqualification & awarding of prize to an alternate winner. If any prize notification letter is returned as undeliverable, winner will be disqualified & an alternate winner may be selected. By participating, entrants agree to be bound by these Official Rules & agree that: 1.) Released Parties & their designees & assigns shall have the right & permission to use (unless prohibited by law) their name, voice, city/state of residence, photograph, and/or likeness for advertising and/or trade and/or any other purpose in any media or format now or hereafter known without further compensation, permission, or notification. 2.) Released Parties & their designees & assigns & all of their respective officers, directors, employees, representatives & agents shall have no liability & will be held harmless for any liability, loss, injury or death to entrant or any other person, including, without limitation, damage to personal or real property, due in whole or in part, directly or indirectly, by reason of the acceptance, possession, use or misuse of a prize (including any travel or prize activity related thereto) or participation in this Sweepstakes. **Winners List:** For the winners' names (available after 4/30/04), send a self-addressed, stamped envelope to be received by 2/28/04 to: MasterCard Holiday Trip-A-Day Giveaway Winners, P.O. Box 13106, Bridgeport, CT 06673-3106.

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created worldwide awareness of the Flecheiros. The effect of that awareness could be the exact opposite of what Possuelo thinks will protect the tribe.

EMILY CACHIGUANGO

Poughkeepsie, New York

I am having a difficult time reconciling Sydney Possuelo's statement "Once you make contact, you begin the process of destroying their universe" with his action in leaving behind a machete and a knife as a peace offering. Is that not contact?

KEN KOSHGARIAN

Saskatoon, Saskatchewan

Who Knew?

I read with amusement how "the cosmos suddenly inflated, becoming unimaginably vast in a fraction of a second." This idea is hardly new. It's frighteningly similar to these ancient words: "In the beginning, God created the heavens. . ."

MICHAEL SCHLITZER

Sterling, Virginia

Lynne Warren's It Matters column about the length of a meter refers to the incomprehensible figure of the distance light travels through a vacuum in 1/299,792,458 of a second. While this may appear to some readers as a completely arbitrary figure, the meter originally had a very real connection to our planet: It was first defined by the French Academy of Sciences as one ten-millionth of the distance between the Pole and the Equator along the meridian that runs through Paris.

PIERRE HOPPA

Cape Town, South Africa

Even in 1799, when two Frenchmen completed the original calculations, they knew that their measurements were a wee bit off, partly because the Earth's rotation causes the planet to flatten at the Poles and bulge at the Equator. Today we know that one ten-millionth of a quadrant is actually 0.2 mm longer than a meter. Although their size-of-the-planet reference was imperfect, the French created a solid platinum bar to the exact length of their calculations and deposited the treasure in their national archives. It became the meter standard for the world.

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FORUM

Geographica

The short piece on baby boomers and their sports injuries [a sidebar to Margaret G. Zackowitz's piece on aging Harley-Davidson riders] brings to mind a famous quip: "The only exercise I get is walking to the funerals of my more athletically inclined friends."

TOM MITCHELL
West Chicago, Illinois

Alaska's Wild Archipelago

There is some irony in the Alaska National Wildlife Refuge's history of protecting the environment. President William Howard Taft's declaration establishing the refuge to save sea otters exempted military activities. Thus it was that the largest U.S. underground nuclear tests—too big for Nevada—came to be conducted under Amchitka Island. The resulting uplift destroyed important sea otter habitat.

JOHN EICHELBERGER
Fairbanks, Alaska

ZipUSA: Pittsburgh

Your photograph of what the Primanti sandwich shop calls a cheesesteak is an insult to any person who has eaten the real thing. As a Pennsylvanian raised in Philadelphia, I can tell you that what is made and sold in Pittsburgh is a far cry from a cheesesteak. A real cheesesteak is sirloin or flank steak grilled to perfection, then smothered in fried onions and Cheez Whiz, all lovingly placed inside an Italian roll. I suggest you devote the same amount of space and attention to the late-night culinary delights of South Philadelphia, the true home of the cheesesteak.

MICHAEL F. GALANTE
Telford, Pennsylvania

I was struck by a glaring and somewhat insensitive contrast in this issue. Your lengthy piece on Zimbabwe, which had hunger as an underlying theme, was immediately followed by a story celebrating the grotesque size and weight of sandwiches in Pittsburgh.

STUART SYKES
Mount Eliza, Australia

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NEXIUM tackles acid reflux at the source. That's important because even a little heartburn, over time, can still mean serious damage to your esophagus. For most people, NEXIUM heals that damage. Your results may vary.

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NEXIUM works by "turning off" many of the pumps that produce acid. Once the amount of acid has been reduced, NEXIUM can begin to heal any erosions caused by acid reflux disease. Most erosions heal in 4 to 8 weeks with NEXIUM. Your results may vary.

Talk with your health care professional to see if NEXIUM is right for you. NEXIUM has a low occurrence of side effects, including headache, diarrhea and abdominal pain. Symptom relief does not rule out serious stomach conditions.

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Please read the important Product Information about NEXIUM on the following page and discuss it with your doctor.

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Please read this summary carefully, and then ask your doctor about NEXIUM.

No advertisement can provide all the information needed to prescribe a drug. This advertisement does not take the place of careful discussions with your doctor. Only your doctor has the training to weigh the risks and benefits of a prescription drug for you.

Nexium® (esomeprazole magnesium) 20-MG, 40-MG Delayed-Release Capsules

BRIEF SUMMARY Before prescribing NEXIUM, please see full Prescribing Information.

INDICATIONS AND USAGE NEXIUM is indicated for the short-term treatment (4 to 8 weeks) in the healing and symptomatic resolution of diagnostically confirmed erosive esophagitis.

CONTRAINDICATIONS NEXIUM is contraindicated in patients with known hypersensitivity to any component of the formulation or to substituted benzimidazoles.

PRECAUTIONS Symptomatic response to therapy with NEXIUM does not preclude the presence of gastric malignancy. Atrophic gastritis has been noted occasionally in gastric corpus biopsies from patients treated long-term with omeprazole, of which NEXIUM is an enantiomer.

Information for Patients: NEXIUM Delayed-Release Capsules should be taken at least one hour before meals. For patients who have difficulty swallowing capsules, one tablespoon of applesauce can be added to an empty bowl and the NEXIUM Delayed-Release Capsule opened, and the pellets carefully emptied onto the applesauce. The pellets should be mixed with the applesauce and then swallowed immediately. The applesauce used should not be hot and should be soft enough to be swallowed without chewing. The pellets should not be chewed or crushed. The pellet/applesauce mixture should not be stored for future use. Antacids may be used while taking NEXIUM.

Drug Interactions: Esomeprazole is extensively metabolized in the liver by CYP2C19 and CYP3A4. *In vitro* and *in vivo* studies have shown that esomeprazole is not likely to inhibit CYPs 1A2, 2A6, 2C9, 2D6, 2E1 and 3A4. No clinically relevant interactions with drugs metabolized by these CYP enzymes would be expected. Drug interaction studies have shown that esomeprazole does not have any clinically significant interactions with phenytoin, warfarin, quinidine, clarithromycin, or amoxicillin. Post-marketing reports of changes in prothrombin measures have been received among patients on concomitant warfarin and esomeprazole therapy. Increases in INR and prothrombin time may lead to abnormal bleeding and even death. Patients treated with proton pump inhibitors and warfarin concomitantly may need to be monitored for increases in INR and prothrombin time. Esomeprazole may potentially interfere with CYP2C19, the major esomeprazole metabolizing enzyme. Coadministration of esomeprazole and diazepam, a CYP2C19 substrate, resulted in a 45% decrease in clearance of diazepam. Increased plasma levels of diazepam were observed 12 hours after dosing and onwards. However, at that time, the plasma levels of diazepam were below the therapeutic interval, and thus this interaction is unlikely to be of clinical relevance. Esomeprazole inhibits gastric acid secretion. Therefore, esomeprazole may interfere with the absorption of drugs where gastric pH is an important determinant of bioavailability (eg, ketoconazole, iron salts and digoxin). Coadministration of oral contraceptives, diazepam, phenytoin, or quinidine did not seem to change the pharmacokinetic profile of esomeprazole.

Carcinogenesis, Mutagenesis, Impairment of Fertility: The carcinogenic potential of esomeprazole was assessed using omeprazole studies. In two 24-month oral carcinogenicity studies in rats, omeprazole at daily doses of 1.7, 3.4, 13.8, 44.0 and 140.8 mg/kg/day (about 0.7 to 57 times the human dose of 40 mg/day expressed on a body surface area basis) produced gastric ECL cell carcinoids in a dose-related manner in both male and female rats; the incidence of this effect was markedly higher in female rats, which had higher blood levels of omeprazole. Gastric carcinoids seldom occur in the untreated rat. In addition, ECL cell hyperplasia was present in all treated groups of both sexes. In one of these studies, female rats were treated with 13.8 mg omeprazole/kg/day (about 5.6 times the human dose on a body surface area basis) for 1 year, then followed for an additional year without the drug. No carcinoids were seen in these rats. An increased incidence of treatment-related ECL cell hyperplasia was observed at the end of 1 year (94% treated vs 10% controls). By the second year the difference between treated and control rats was much smaller (46% vs 26%) but still showed more hyperplasia in the treated group. Gastric adenocarcinoma was seen in one rat (2%). No similar tumor was seen in male or female rats treated for 2 years. For this strain of rat no similar tumor has been noted historically, but a finding involving only one tumor is difficult to interpret. A 78-week mouse carcinogenicity study of omeprazole did not show increased tumor occurrence, but the study was not conclusive. Esomeprazole was negative in the Ames mutation test, in the *in vivo* rat bone marrow cell chromosome aberration test, and the *in vivo* mouse micronucleus test. Esomeprazole, however, was positive in the *in vitro* human lymphocyte chromosome aberration test. Omeprazole was positive in the *in vitro* human lymphocyte chromosome aberration test, the *in vivo* mouse bone marrow cell chromosome aberration test, and the *in vivo* mouse micronucleus test. The potential effects of esomeprazole on fertility and reproductive performance were assessed using omeprazole studies. Omeprazole at oral doses up to 138 mg/kg/day in rats (about 56 times the human dose on a body surface area basis) was found to have no effect on reproductive performance of parental animals.

Pregnancy: Teratogenic Effects Pregnancy Category B—Teratology studies have been performed in rats at oral doses up to 280 mg/kg/day (about 57 times the human dose on a body surface area basis) and in rabbits at oral doses up to 86 mg/kg/day (about 35 times the human dose on a body surface area basis) and have revealed no evidence of impaired fertility or harm to the fetus due to esomeprazole. There are, however, no adequate and well-controlled studies in pregnant women. Because animal reproduction studies are not always predictive of human response, this drug should be used during pregnancy only if clearly needed. Teratology studies conducted with omeprazole in rats at oral doses up to 138 mg/kg/day (about 56 times the human dose on a body surface area basis) and in rabbits at doses up to 69 mg/kg/day (about 56 times the human dose on a body surface area basis) did not disclose any evidence for a teratogenic potential of omeprazole. In rabbits, omeprazole at a dose range of 6.9 to 69.1 mg/kg/day (about 5.5 to 56 times the human dose on a body surface area basis) produced dose-related increases in embryo-lethality, fetal resorptions, and pregnancy disruptions. In rats, dose-related embryo/fetal toxicity and postnatal developmental toxicity were observed in offspring resulting from parents treated with omeprazole at 13.8 to 138.0 mg/kg/day

(about 5.6 to 56 times the human doses on a body surface area basis). There are no adequate and well-controlled studies in pregnant women. Sporadic reports have been received of congenital abnormalities occurring in infants born to women who have received omeprazole during pregnancy.

Nursing Mothers: The excretion of esomeprazole in milk has not been studied. However, omeprazole concentrations have been measured in breast milk of a woman following oral administration of 20 mg. Because esomeprazole is likely to be excreted in human milk, because of the potential for serious adverse reactions in nursing infants from esomeprazole, and because of the potential for tumorigenicity shown for omeprazole in rat carcinogenicity studies, a decision should be made whether to discontinue nursing or to discontinue the drug, taking into account the importance of the drug to the mother.

Pediatric Use: Safety and effectiveness in pediatric patients have not been established.

Geriatric Use: Of the total number of patients who received NEXIUM in clinical trials, 778 were 65 to 74 years of age and 124 patients were \geq 75 years of age. No overall differences in safety and efficacy were observed between the elderly and younger individuals, and other reported clinical experience has not identified differences in responses between the elderly and younger patients, but greater sensitivity of some older individuals cannot be ruled out.

ADVERSE REACTIONS The safety of NEXIUM was evaluated in over 10,000 patients (aged 18-84 years) in clinical trials worldwide including over 7,400 patients in the United States and over 2,600 patients in Europe and Canada. Over 2,900 patients were treated in long-term studies for up to 6-12 months. In general, NEXIUM was well tolerated in both short- and long-term clinical trials. The safety in the treatment of healing of erosive esophagitis was assessed in four randomized comparative clinical trials, which included 1,240 patients on NEXIUM 20 mg, 2,434 patients on NEXIUM 40 mg, and 3,008 patients on omeprazole 20 mg daily. The most frequently occurring adverse events (\geq 1%) in all three groups was headache (5.5, 5.0, and 3.8, respectively) and diarrhea (no difference among the three groups). Nausea, flatulence, abdominal pain, constipation, and dry mouth occurred at similar rates among patients taking NEXIUM or omeprazole. Additional adverse events that were reported as possibly or probably related to NEXIUM with an incidence $<$ 1% are listed below by body system.

Body as a Whole: abdomen enlarged, allergic reaction, asthenia, back pain, chest pain, chest pain substernal, facial edema, peripheral edema, hot flushes, fatigue, fever, flu-like disorder, generalized edema, leg edema, malaise pain, rigors.

Cardiovascular: flushing, hypertension, tachycardia.

Endocrine: goiter.

Gastrointestinal: bowel irregularity, constipation aggravated, dyspepsia, dysphagia, dysplasia GI, epigastric pain, eructation, esophageal disorder, frequent stools, gastroenteritis, GI hemorrhage, GI symptoms not otherwise specified, hiccup, melena, mouth disorder, pharynx disorder, rectal disorder, serum gastrin increased, tongue disorder, tongue edema, ulcerative stomatitis, vomiting.

Hearing: earache, tinnitus.

Hematologic: anemia, anemia hypochromic, cervical lymphadenopathy, epistaxis, leukocytosis, leukopenia, thrombocytopenia.

Hepatic: bilirubinemia, hepatic function abnormal, SGOT increased, SGPT increased.

Metabolic/Nutritional: glycosuria, hyperuricemia, hyponatremia, increased alkaline phosphatase, thirst, vitamin B12 deficiency, weight increase, weight decrease.

Musculoskeletal: arthralgia, arthritis aggravated, arthropathy, cramps, fibromyalgia syndrome, hernia, polymyalgia rheumatica.

Nervous System/Psychiatric: anorexia, apathy, appetite increased, confusion, depression aggravated, dizziness, hypertonia, nervousness, hypoesthesia, impotence, insomnia, migraine, migraine aggravated, paresthesia, sleep disorder, somnolence, tremor, vertigo, visual field defect.

Reproductive: dysmenorrhea, menstrual disorder, vaginitis.

Respiratory: asthma aggravated, coughing, dyspnea, larynx edema, pharyngitis, rhinitis, sinusitis.

Skin and Appendages: acne, angioedema, dermatitis, pruritus, pruritus ani, rash, rash erythematous, rash maculo-papular, skin inflammation, sweating increased, urticaria.

Special Senses: otitis media, parosmia, taste loss, taste perversion.

Urogenital: abnormal urine, albuminuria, cystitis, dysuria, fungal infection, hematuria, micturition frequency, monilia, genital monilia, polyuria.

Visual: conjunctivitis, vision abnormal.

Endoscopic findings that were reported as adverse events include: duodenitis, esophagitis, esophageal stricture, esophageal ulceration, esophageal varices, gastric ulcer, gastritis, hernia, benign polyps or nodules, Barrett's esophagus, and mucosal discoloration.

Postmarketing Reports - There have been spontaneous reports of adverse events with postmarketing use of esomeprazole. These reports have included rare cases of anaphylactic reaction. Other adverse events not observed with NEXIUM, but occurring with omeprazole can be found in the omeprazole package insert, **ADVERSE REACTIONS** section.

OVERDOSAGE A single oral dose of esomeprazole at 510 mg/kg (about 103 times the human dose on a body surface area basis), was lethal to rats. The major signs of acute toxicity were reduced motor activity, changes in respiratory frequency, tremor, ataxia and intermittent clonic convulsions. There have been some reports of overdosage with esomeprazole. Reports have been received of overdosage with omeprazole in humans. Doses ranged up to 2,400 mg (120 times the usual recommended clinical dose). Manifestations were variable, but included confusion, drowsiness, blurred vision, tachycardia, nausea, diaphoresis, flushing, headache, dry mouth, and other adverse reactions similar to those seen in normal clinical experience (see omeprazole package insert-**ADVERSE REACTIONS**). No specific antidote for esomeprazole is known. Since esomeprazole is extensively protein bound, it is not expected to be removed by dialysis. In the event of overdosage, treatment should be symptomatic and supportive. As with the management of any overdose, the possibility of multiple drug ingestion should be considered. For current information on treatment of any drug overdose, a certified Regional Poison Control Center should be contacted. Telephone numbers are listed in the Physicians' Desk Reference (PDR) or local telephone book.

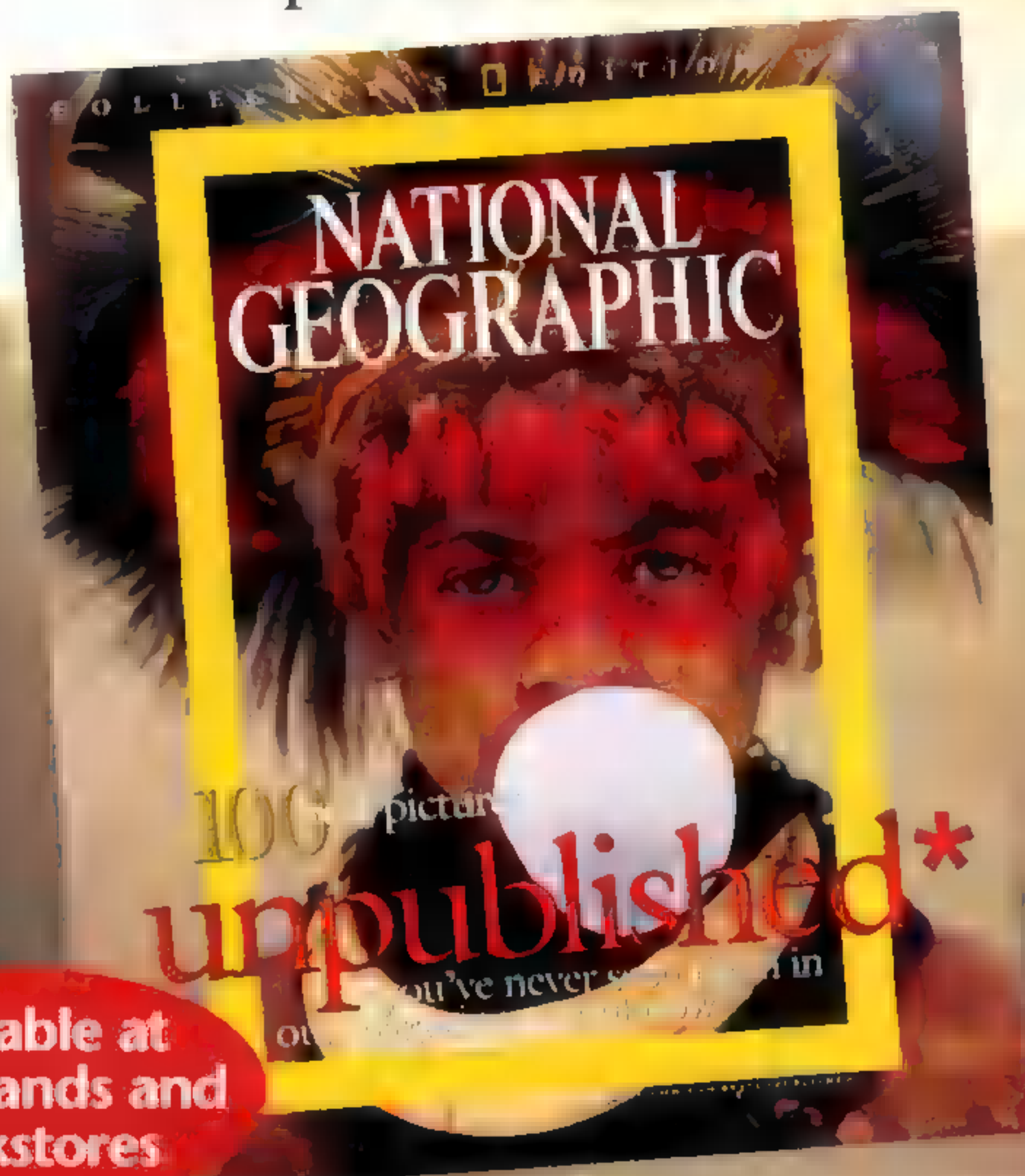
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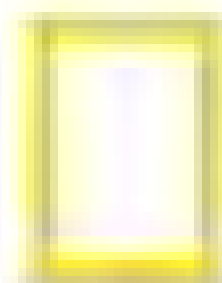
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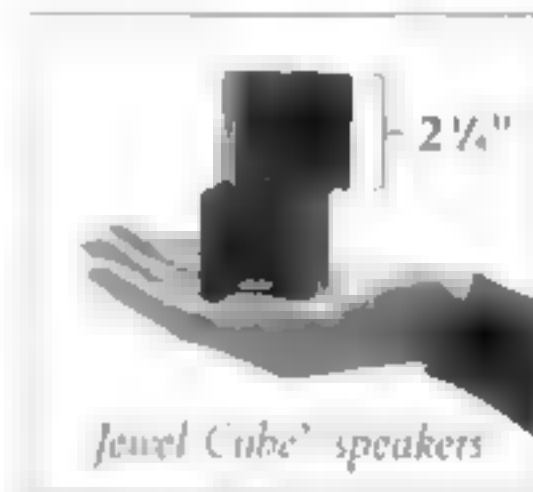
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Lifestyle 35 DVD system shown

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G E O G R

T H E P E O P L E , P L A C E S , A N D

AVIATION

The Wright Stuff

How the Flyer took wing

Wood, muslin, wires, and a simple engine powering a bicycle-style transmission hardly seem the stuff of a technological revolution. But when Wilbur and Orville Wright faced their as yet unnamed biplane into the Atlantic winds blowing across North Carolina dunes a hundred years ago on December 17, they had high hopes. Through careful experimentation with gliders and miniature wings tested in a small wind tunnel, the two bicycle mechanics had ironed out one problem after another: how to produce the lift and propulsion needed to get into the air and stay aloft; how to control pitch, roll, yaw; and how to make all

the necessary innovations work together in a single craft. Now they had a powered biplane with a 40-foot wingspan, and they believed it was aeronautically sound. With Orville at the controls, the plane accelerated along a short rail—and took to the air. The Wrights had their Flyer.

—K. M. Kostyal

Elevator

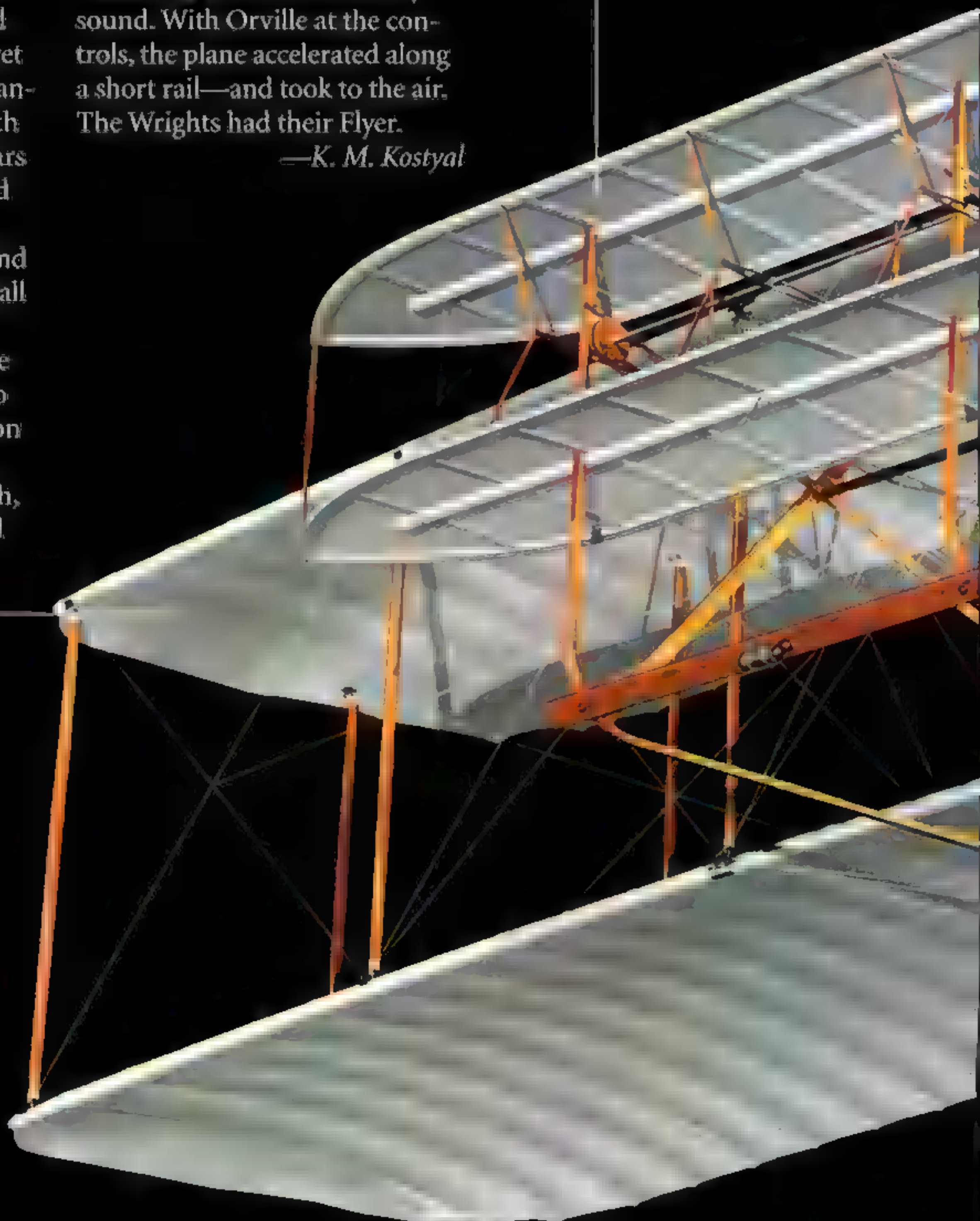
The Wrights' "forward rudder," as they called the elevator, was mounted in front of the wings—a placement known as a canard configuration. Using a hand-held lever, the pilot tilted the elevator up or down to change the plane's altitude.

Warping Wings

The trailing edges of the Flyer's wings were flexible and performed the same function as ailerons on modern aircraft. The pilot controlled them with his hands, supported in a sliding cradle connected to the wing-warping system. Moving his hands to the right twisted the wingtip down and the opposite wingtip up, causing the plane to turn.

WRIGHT BROTHERS

Use an interactive 3-D model to peel back the layers of the Wright Flyer and see how the famous biplane was built when you visit nationalgeographic.com/ngm/0312.



APHICA

CREATURES OF OUR UNIVERSE

Bicycle Transmission

The trusty sprocket-and-chain system used on bicycles linked the Flyer's gasoline engine (Inset, bottom right) to the propellers. The shaft leading from the flywheel was crossed so the propellers would rotate in opposite directions, balancing their rotational force.

Muslin Skin

The Flyer's muslin covering was integral to its flexibility. Wing ribs and spars floated inside fabric pockets instead of being fastened rigidly together, letting the wings twist easily. After trying a French sateen on their first glider, the Wrights switched to tightly woven muslin. By fixing it to the wings diagonally to the weave of the fabric, the brothers gave the Flyer structural strength while maintaining its flexibility.

Twin Propellers

Problem: How to achieve enough thrust to lift the Flyer into the air. A bigger engine? Too heavy.
Solution: Shape the propeller blades like wings, with one side curved and the other flat. This shape creates a difference in air pressure that produces lift (in the case of a wing) and forward thrust in the case of a propeller.

Movable Tail

Adding a movable vertical tail to their craft solved a problem that bedeviled the Wrights on their earlier gliders: the inability to control adverse yaw—the tendency of the aircraft to turn in the opposite direction of a turn.



ART BY GRIFF WASON



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CULTURE

British Cool on Hot Tea

But Turkish steepers climb

There's less time for teatime in the U.K. these days. Historically the British ranked as the world's leading tea drinkers, but rushed lifestyles—along with a new thirst for alternative beverages—have caused their consumption of tea to plummet in recent years.

According to Datamonitor, a London-based business information firm, the British consumed 4.94 pounds of tea per person in 2002. That amounts to about 1,100 cups—down from 1,300 in 1997. Datamonitor analyst John Band points to several reasons for the trend. Younger British consumers are drinking more iced tea and trendy specialty coffees. They tend to dismiss hot steeped tea as old-fashioned, slow to prepare, and inconvenient to drink on the run.



OWEN FRANKEN, CORBIS

And although they are buying more herbal, fruit, and green teas, consumption of these teas is minuscule compared to black tea, the mainstay of the traditional "cuppa."

Now the world champion tea drinkers are the Turks, whose tea consumption in 2002 came to 5.05 pounds per person. Turkish custom calls for endless small servings (above). A tea-loving Turk can knock back more than 20 tiny glasses of the hot brew daily. Turkish coffee may be world famous, but inside Turkey tea is more popular. "There's a saying in my country," says

Turkish tea authority Pelin Aylangan. "Conversations without tea are like a night sky without the moon."

—Margaret G. Zackowitz

2002 Tea Totals

(All types of tea, per person)

Turkey	5.05 pounds
U.K.	4.94 pounds
Ireland	3.33 pounds
Hong Kong	3.24 pounds
Poland	2.67 pounds
Morocco	2.60 pounds
Russia	2.60 pounds
Egypt	2.47 pounds
Israel	2.38 pounds

IN/OUT



KEVIN MURPHY

Its Number Was Up

Some people consider "666" a sign of evil—the "number of the beast" in the New Testament Book of Revelation. That's why two-lane U.S. 666 through the Four Corners area, named because it was the sixth spur off U.S. 66, is now U.S. 491. The road's satanic connotation caused such protest among the Navajo, whose New Mexico lands it crosses, that Governor Bill Richardson announced the name change last June. But old 666 never was a highway to hell. It went to Utah.

—MGZ

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DAVID HIGGS/TEPA (ALL)

CONSERVATION

Kill a Cat, Save a Numbat?

Activist's approach riles critics, but gets results

"I love cats, but I can never eat a whole one." That's the kind of thing John Wamsley (top right, in cat-skin hat) likes to say to ruffle his critics' feathers. But if the outspoken Wamsley is curmudgeonly about cats, it's an attitude that springs from his love for Australia's native wildlife, which he's been working to save for most of his 65 years.

It was those darn feral felines, along with rabbits and foxes, that started Wamsley's activism as a boy. The invasive species eradicated the native animals from his childhood backyard, which included 166 acres of bush. "It was a wonderland," he says. Bandicoots, bettongs, potoroos, "they were everywhere. When they all started to disappear, nobody cared. So it became my mission to do something."

That something was to buy up land, fence out the ferals (above), kill off the invasive animals, and reintroduce native ones—a strategy others are now copying. At his first wildlife sanctuary, Warrawong near Adelaide, native

species rebounded. So Wamsley founded Earth Sanctuaries Ltd. (ESL), a publicly traded company—the first of its kind devoted to conservation—to fund more.

Some folks argue that trusting wildlife to private investors is risky because of the temptation to put profit before protection. But Wamsley sees economics as conservation's necessary partner. "Other methods give us warm fuzzies, but they're just a facade. This way we have measurable outcomes. ESL has been extremely successful."

Indeed, Wamsley's approach has helped rescue some of Australia's endangered animals, including the woylie, bilby, and numbat. Many more, like those at right, now thrive in invasive-proof mini-ecosystems. ESL's newest park is Waratah, near Sydney, and Wamsley is already seeking his next plot. He hopes eventually to convert one percent of Australia back to feral-free land. "I'll be doing this until I die," he promises.

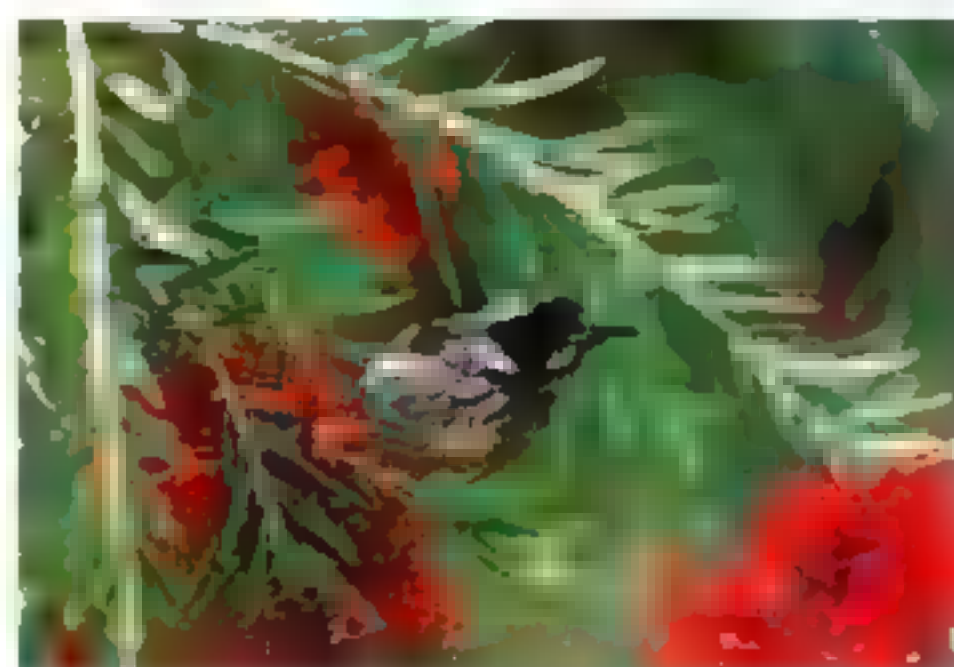
—Jennifer Steinberg Holland



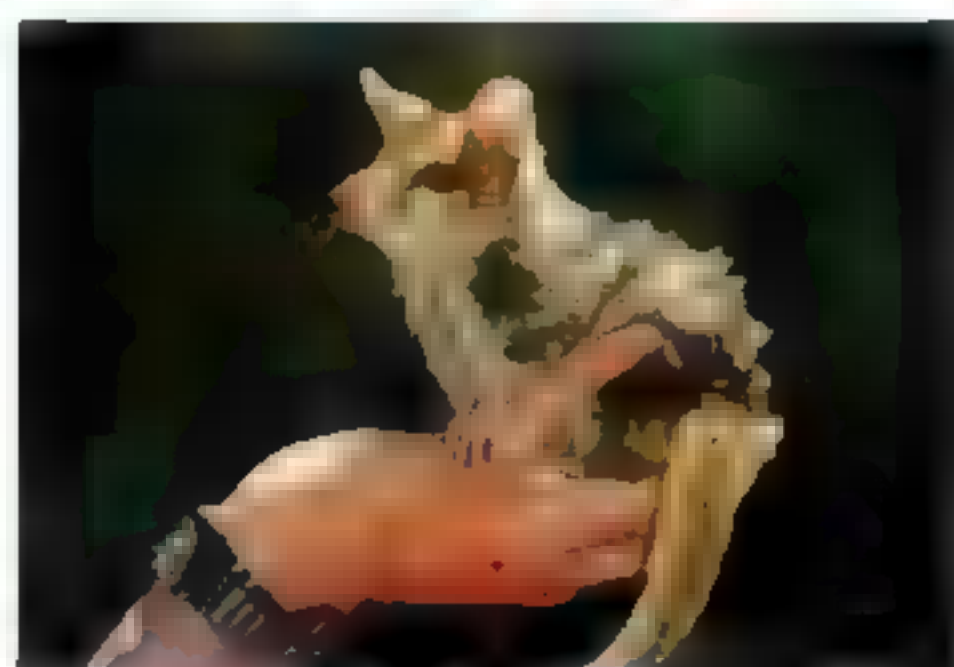
JOHN WAMSLEY, FOUNDER, EARTH SANCTUARIES LTD.



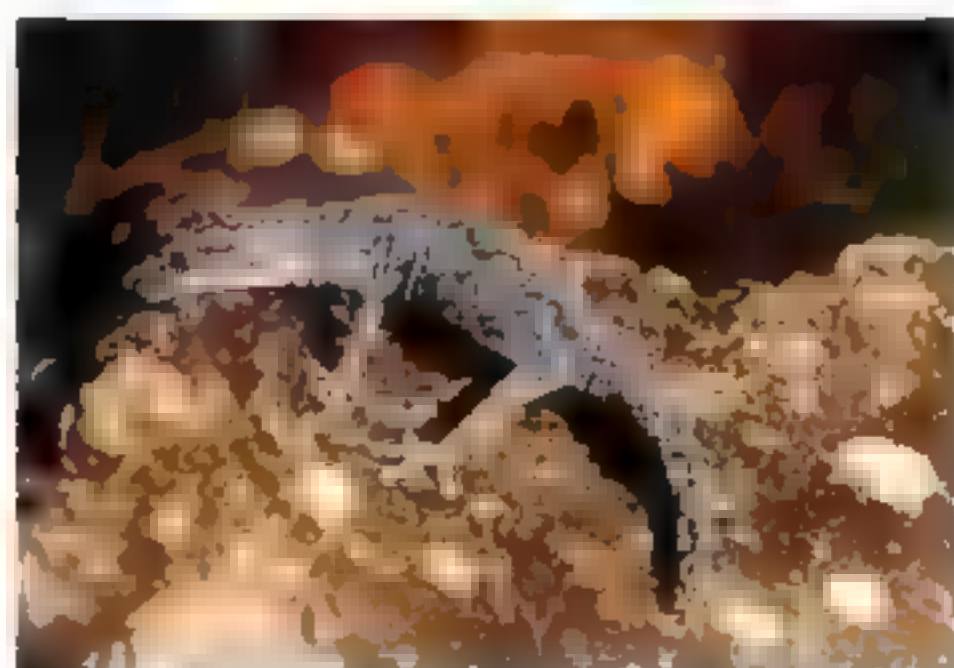
BILBY OR RABBIT-EARED BANDICOOT (MACROTIS LAGOTIS)



NEW HOLLAND HONEYEATER (MYZOMELA NOVAE HOLLANDIAE)



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Important CELEBREX information. Prescription CELEBREX is not for everyone. People with aspirin-sensitive asthma or allergic reactions due to aspirin or other arthritis medicines or certain drugs called sulfonamides should not take CELEBREX. In rare cases, serious stomach problems such as bleeding can occur without warning. The most common side effects in clinical trials were indigestion, diarrhea and abdominal pain.

CELEBREX should not be taken in late pregnancy. Tell your doctor if you have kidney or liver problems.

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Brief summary of prescribing information.

INDICATIONS AND USAGE

For relief of the signs and symptoms of osteoarthritis (OA), and of rheumatoid arthritis (RA) in adults. For the management of acute pain in adults. For the treatment of primary dysmenorrhea.

CONTRAINDICATIONS

CELEBREX is contraindicated in patients with known hypersensitivity to celecoxib. CELEBREX should not be given to patients who have demonstrated allergic type reactions to sulfonamides or to those who have experienced asthma, urticaria, or allergic-type reactions after taking aspirin or other non-steroidal anti-inflammatory drugs (NSAIDs). Severe, rarely fatal, anaphylactoid-like reactions to NSAIDs have been reported in such patients (see WARNINGS, Anaphylactoid Reactions, and PRECAUTIONS, Preexisting Asthma).

WARNINGS

Gastrointestinal (GI) Effects – Risk of GI Ulceration, Bleeding, and Perforation: Serious GI toxicity (bleeding, ulceration, and perforation of the stomach or intestine) can occur at any time, with or without warning symptoms, in patients treated with NSAIDs. Minor upper GI problems, such as dyspepsia, are common and may also occur at any time during NSAID therapy. Therefore, physicians and patients should remain alert for ulceration and bleeding, even in the absence of previous GI tract symptoms (see PRECAUTIONS – Hematological Effects). Inform patients about the signs and/or symptoms of serious GI toxicity and the steps to take if they occur. Only 1 in 5 patients who develop a serious upper GI adverse event on NSAID therapy is symptomatic. Upper GI ulcers, gross bleeding or perforation, caused by NSAIDs, occur in about 1% of patients treated for 3-6 months, and in about 2.4% of patients treated for one year. These trends continue thus, increasing the likelihood of developing a serious GI event at some time during the course of therapy. However, even short-term therapy is not without risk. Prescribe NSAIDs with extreme caution in patients with a prior history of ulcer disease or GI bleeding. Most spontaneous reports of fatal GI events are in elderly or debilitated patients and therefore take special care in treating this population. **To minimize the potential risk for an adverse GI event, use the lowest effective dose for the shortest possible duration.** For high risk patients, consider alternate therapies that do not involve NSAIDs. Studies have shown that patients with a prior history of peptic ulcer disease and/or GI bleeding and who use NSAIDs, have a greater than 10 fold higher risk for developing a GI bleed than patients with neither of these risk factors. Studies have identified several other co-therapies or co-morbid conditions that may increase the risk for GI bleeding such as: treatment with oral corticosteroids or anticoagulants, longer duration of NSAID therapy, smoking, alcoholism, older age, and poor general health status.

CLASS Study: The estimated cumulative rates at 9 months of *complicated and symptomatic ulcers* (an adverse event similar but not identical to the "upper GI ulcers, gross bleeding or perforation" described in the preceding paragraphs) for patients treated with CELEBREX 400 mg BID (see Special Studies – Use with Aspirin) are described in the following table. The table also displays results for patients less than or greater than or equal to the age of 65 years. The differences in rates between the CELEBREX alone and CELEBREX with ASA groups may be due to the higher risk for GI events in ASA users.

In a small number of patients with a history of ulcer disease, the *complicated and symptomatic ulcer* rates in patients taking CELEBREX alone or CELEBREX with ASA were, respectively, 2.56% (n=243) and 6.86% (n=91) at 48 weeks. These results are to be expected in patients with a prior history of ulcer disease (see WARNINGS – Gastrointestinal (GI) Effects – Risk of GI Ulceration, Bleeding, and Perforation).

Complicated and symptomatic ulcer rates in patients taking CELEBREX 400 mg BID (Kaplan-Meier rates at 9 months) based on risk factors were: All Patients - Celebrex alone (n=3105) 0.78% and Celebrex with ASA (n=882) 2.19%; Patients < 65 Years - Celebrex alone (n=2025) 0.47% and Celebrex with ASA (n=403) 1.26%; Patients ≥ 65 Years - Celebrex alone (n=1080) 1.40% and Celebrex with ASA (n=479) 3.06%.

Anaphylactoid Reactions: As with NSAIDs in general, anaphylactoid reactions have occurred in patients without known prior exposure to CELEBREX. In post-marketing experience, rare cases of anaphylactic reactions and angioedema have been reported in patients receiving CELEBREX. CELEBREX should not be given to patients with the aspirin triad. This symptom complex typically occurs in asthmatic patients who experience rhinitis with or without nasal polyps, or who exhibit severe, potentially fatal bronchospasm after taking aspirin or other NSAIDs (see CONTRAINDICATIONS and PRECAUTIONS, Preexisting Asthma). Seek emergency help in cases where an anaphylactoid reaction occurs.

Advanced Renal Disease: Treatment with CELEBREX is not recommended, but if it is used, monitoring of kidney function is advised.

Pregnancy: Avoid CELEBREX in late pregnancy because it may cause premature closure of the ductus arteriosus.

PRECAUTIONS

General: CELEBREX cannot be expected to substitute for corticosteroids or to treat corticosteroid insufficiency. The pharmacological activity of CELEBREX in reducing inflammation, and possibly fever, may diminish the utility of these diagnostic signs in detecting infectious complications of presumed noninfectious, painful conditions.

Hepatic Effects: Borderline elevations of one or more liver-associated enzymes may occur in up to 15% of patients taking NSAIDs, and notable elevations of ALT or AST (about 3 or more times the upper limit of normal) have been reported in approximately 1% of patients in clinical trials with NSAIDs. These lab abnormalities may or may not change with continuing therapy. Rare cases of severe hepatic reactions, including jaundice and fatal fulminant hepatitis, liver necrosis and hepatic failure (some with fatal outcome) have been reported with NSAIDs, including CELEBREX. In controlled clinical trials of CELEBREX, the incidence of borderline elevations (greater than or equal to 1.2 times and less than 3 times the upper limit of normal) of liver associated enzymes was 6% for CELEBREX and 5% for placebo, and about 0.2% of patients taking CELEBREX and 0.3% of patients taking placebo had notable elevations of ALT and AST. A patient with symptoms and/or signs suggesting liver dysfunction, or in whom an abnormal liver test has occurred, should be monitored carefully for evidence of the development of a more severe hepatic reaction while on therapy with CELEBREX. Discontinue CELEBREX if clinical signs and symptoms of liver disease develop, or if systemic manifestations occur (e.g., eosinophilia, rash).

Renal Effects: Long-term administration of NSAIDs has resulted in renal papillary necrosis and other renal injury. Renal toxicity has also been seen in patients in whom renal prostaglandins have a compensatory role in the maintenance of renal perfusion. In these patients, NSAIDs may cause a dose-dependent reduction in prostaglandin formation and, secondarily, in renal blood flow, which may precipitate overt renal decompensation. Patients at greatest risk of this reaction are those with impaired renal function, heart failure, or liver dysfunction, those taking diuretics and ACE inhibitors, and the elderly. Discontinuation of NSAID therapy is usually followed by recovery to the pretreatment state. Clinical trials with CELEBREX have shown renal effects similar to those observed with comparator NSAIDs. Use caution when initiating treatment with CELEBREX in patients with considerable dehydration. Rehydrate patients first and then start therapy with CELEBREX. Use caution in patients with pre-existing kidney disease (see WARNINGS, Advanced Renal Disease).

Hematological Effects: In controlled clinical trials the incidence of anemia was 0.6% with CELEBREX and 0.4% with placebo. Patients on long-term treatment with CELEBREX should have their hemoglobin or hematocrit checked if they exhibit any signs or symptoms of anemia or blood loss. CELEBREX does not generally affect platelet counts, prothrombin time

(PT), or partial thromboplastin time (PTT), and does not inhibit platelet aggregation at indicated dosages.

Fluid Retention, Edema, and Hypertension: Fluid retention and edema have been observed in some patients taking CELEBREX (see ADVERSE REACTIONS). In the CLASS study (see Special Studies – Use with Aspirin), the Kaplan-Meier cumulative rates at 9 months of peripheral edema in patients on CELEBREX 400 mg BID (4-fold and 2-fold the recommended OA and RA doses, respectively), ibuprofen 800 mg TID and diclofenac 75 mg BID were 4.5%, 6.9% and 4.7%, respectively. The rates of hypertension in the CELEBREX, ibuprofen and diclofenac treated patients were 2.4%, 4.2% and 2.5%, respectively. As with other NSAIDs, CELEBREX should be used with caution in patients with fluid retention, hypertension, or heart failure.

Preexisting Asthma: Do not use in patients with aspirin-sensitive asthma because of the risk of severe bronchospasm. Use with caution in patients with preexisting asthma.

Information for Patients: Inform patients of the following: GI bleeding which may result in hospitalization and fatal outcomes; to be alert for signs and symptoms of ulcerations and bleeding, and seek medical advice should these be observed; to promptly report GI ulceration or bleeding, skin rash, unexplained weight gain, or edema; to stop therapy and seek immediate medical help if they experience warning signs and symptoms of hepatotoxicity; to seek immediate emergency help in the case of an anaphylactoid reaction; and to avoid CELEBREX in late pregnancy.

Laboratory Tests: Because serious GI tract ulcerations and bleeding can occur without warning symptoms, monitor for signs or symptoms of GI bleeding. In controlled clinical trials, elevated BUN occurred more frequently in patients receiving CELEBREX compared with patients on placebo. This laboratory abnormality was also seen in patients who received comparator NSAIDs in these studies. The clinical significance of this abnormality has not been established.

Drug Interactions: General: Celecoxib metabolism is predominantly mediated via cytochrome P450 2C9 in the liver. Co-administration of celecoxib with drugs that are known to inhibit 2C9 should be done with caution. *In vitro* studies indicate that celecoxib, although not a substrate, is an inhibitor of cytochrome P450 2D6. Therefore, there is a potential for an *in vivo* drug interaction with drugs that are metabolized by P450 2D6. **ACE-inhibitors:** Reports suggest that NSAIDs may diminish the antihypertensive effect of Angiotensin Converting Enzyme (ACE) inhibitors. **Furosemide:** Clinical studies, and post marketing observations, have shown that NSAIDs can reduce the natriuretic effect of furosemide and thiazides in some patients. **Aspirin:** CELEBREX can be used with low-dose aspirin; however, concomitant administration increases the rate of GI ulceration or other complications, compared to use of CELEBREX alone. **Because of its lack of platelet effects, CELEBREX is not a substitute for aspirin for cardiovascular prophylaxis.** **Fluconazole:** Concomitant administration of fluconazole 200 mg QD resulted in a two-fold increase in celecoxib plasma concentration is due to the inhibition of celecoxib metabolism via P450 2C9 by fluconazole. Initiate CELEBREX at the lowest recommended dose in patients receiving fluconazole. **Lithium:** Mean steady-state lithium plasma levels increased approximately 17% in healthy subjects receiving lithium 450 mg BID with CELEBREX 200 mg BID compared with those receiving lithium alone. Closely monitor patients on lithium when CELEBREX is introduced or withdrawn. **Methotrexate:** CELEBREX did not have a significant effect on the pharmacokinetics of methotrexate in rheumatoid arthritis patients. **Warfarin:** Monitor anticoagulant activity, particularly in the first few days, after initiating or changing therapy with CELEBREX in patients receiving warfarin or similar agents; these patients are at an increased risk of bleeding complications. In healthy subjects receiving daily doses of 2-5 mg of warfarin, celecoxib did not alter the anticoagulant effect of warfarin as determined by prothrombin time. However, in post-marketing experience, bleeding events have been reported, predominantly in the elderly, in association with increases in prothrombin time in patients receiving CELEBREX concurrently with warfarin. **Carcinogenesis, mutagenesis, impairment of fertility:** Celecoxib was not carcinogenic in rats given oral doses up to 200 mg/kg for males and 10 mg/kg for females (approximately 2- to 4-fold the human exposure as measured by the AUC₀₋₂₄ at 200 mg BID) or in mice given oral doses up to 25 mg/kg for males and 50 mg/kg for females (approximately equal to human exposure as measured by the AUC₀₋₂₄ at 200 mg BID) for two years. Celecoxib was not mutagenic in an Ames test and a mutation assay in Chinese hamster ovary (CHO) cells, nor clastogenic in a chromosome aberration assay in CHO cells and an *in vivo* micronucleus test in rat bone marrow. Celecoxib did not impair male and female fertility in rats at oral doses up to 600 mg/kg/day (approximately 11-fold human exposure at 200 mg BID based on the AUC₀₋₂₄). **Pregnancy: Teratogenic effects:** Pregnancy Category C. Celecoxib at oral doses ≥ 150 mg/kg/day (about 2-fold human exposure at 200 mg BID as measured by AUC₀₋₂₄), caused an increased incidence of ventricular septal defects, a rare event, and fetal alterations, such as ribs fused, sternbrae fused and sternbrae malformation when rabbits were treated throughout organogenesis. A dose-dependent increase in diaphragmatic hernias was observed when rats were given celecoxib at oral doses ≥ 30 mg/kg/day (about 6-fold human exposure based on the AUC₀₋₂₄ at 200 mg BID) throughout organogenesis. There are no studies in pregnant women. Use CELEBREX during pregnancy only if the potential benefit justifies the potential risk to the fetus. **Nonteratogenic effects:** Celecoxib produced pre- and post-implantation losses and reduced embryo/fetal survival in rats at oral dosages ≥ 50 mg/kg/day (about 8-fold human exposure based on the AUC₀₋₂₄ at 200 mg BID). These changes are expected with inhibition of prostaglandin synthesis and are not the result of permanent alteration of female reproductive function, nor are they expected at clinical exposures. No human studies have been conducted on the effect of celecoxib on the closure of the ductus arteriosus. Use of CELEBREX during the third trimester of pregnancy should be avoided. **Labor and delivery:** Celecoxib produced no evidence of delayed labor or parturition at oral doses up to 100 mg/kg in rats (about 7-fold human exposure as measured by the AUC₀₋₂₄ at 200 mg BID). The effects of CELEBREX on labor and delivery in pregnant women are unknown. **Nursing mothers:** It is not known whether this drug is excreted in human milk. Because many drugs are excreted in human milk and because of the potential for serious adverse reactions in nursing infants from CELEBREX, a decision should be made whether to discontinue nursing or to discontinue the drug, taking into account the importance of the drug to the mother. **Pediatric Use:** Safety and effectiveness in pediatric patients below the age of 18 years have not been evaluated. **Geriatric Use:** Of the total number of patients who received CELEBREX in clinical trials, more than 3,300 were 65-74 years of age, while approximately 1,300 additional patients were 75 years and over. No substantial differences in effectiveness were observed between these subjects and younger subjects. In clinical studies comparing renal function as measured by the GFR, BUN and creatinine, and platelet function as measured by bleeding time and platelet aggregation, the results were not different between elderly and young volunteers. However, as with other NSAIDs, including those that selectively inhibit COX-2, there have been more spontaneous post-marketing reports of fatal GI events and acute renal failure in the elderly than in younger patients (see WARNINGS – Gastrointestinal (GI) Effects – Risk of GI Ulceration, Bleeding, and Perforation).

ADVERSE REACTIONS

Adverse events occurring in ≥2% of Celebrex patients from Celebrex premarketing controlled arthritis trials, regardless of causality at recommended doses (n=4146): abdominal pain 4.1%, diarrhea 5.6%, dyspepsia 8.8%, flatulence 2.2%, nausea 3.5%, back pain 2.8%, peripheral edema 2.1%, injury-accidental 2.9%, dizziness 2.0%, headache 15.8%, insomnia 2.3%, pharyngitis 2.3%, rhinitis 2.0%, sinusitis 5.0%, upper respiratory tract infection 8.1%, rash 2.2%. 7.1% of patients receiving CELEBREX and 6.1% for placebo discontinued due to adverse events in placebo or active controlled clinical trials. Among the most common reasons for discontinuation due to adverse events in the CELEBREX treatment groups were dyspepsia and abdominal pain (0.8% and 0.7%, respectively). Among placebo patients, 0.6% discontinued due to dyspepsia and 0.6% due to abdominal pain. The following adverse events occurred in 0.1-1.9% of patients regardless of causality.

Celebrex (100-200 mg BID or 200 mg QD): GI: Constipation, diverticulitis, dysphagia, eructation, esophagitis, gastritis, gastroenteritis, gastroesophageal reflux, hemorrhoids, hiatal hernia, melena, dry mouth, stomatitis, tenesmus, tooth disorder, vomiting;

Cardiovascular: Aggravated hypertension, angina pectoris, coronary artery disorder, myocardial infarction; **General:** Allergy aggravated, allergic reaction, asthenia, chest pain, cyst NOS, edema generalized, face edema, fatigue, fever, hot flushes, influenza-like symptoms, pain, peripheral pain; **Resistance mechanism disorders:** Herpes simplex, herpes zoster, infection bacterial, infection fungal, infection soft tissue, infection viral, moniliasis, moniliasis genital, otitis media; **Central, peripheral nervous system:** Leg cramps, hypertonia, hypoesthesia, migraine, neuralgia, neuropathy, paresthesia, vertigo; **Female reproductive:** Breast fibroadenosis, breast neoplasm, breast pain, dysmenorrhea, menstrual disorder, vaginal hemorrhage, vaginitis; **Male reproductive:** Prostatic disorder; **Hearing and vestibular:** Deafness, ear abnormality, earache, tinnitus; **Heart rate and rhythm:** Palpitation, tachycardia; **Liver and biliary system:** Hepatic function abnormal, SGOT increased, SGPT increased; **Metabolic and nutritional:** BUN increased, CPK increased, diabetes mellitus, hypercholesterolemia, hyperglycemia, hypokalemia, NPN increase, creatinine increased, alkaline phosphatase increased, weight increase; **Musculoskeletal:** Arthralgia, arthrosis, bone disorder, fracture accidental, myalgia, neck stiffness, synovitis, tendinitis; **Platelets (bleeding or clotting):** Ecchymosis, epistaxis, thrombocytopenia; **Psychiatric:** Anorexia, anxiety, appetite increased, depression, nervousness, somnolence; **Hemic:** Anemia; **Respiratory:** Bronchitis, bronchospasm, bronchospasm aggravated, coughing, dyspnea, laryngitis, pneumonia; **Skin and appendages:** Alopecia, dermatitis, nail disorder, photosensitivity reaction, pruritus, rash erythematous, rash maculopapular, skin disorder, skin dry, sweating increased, urticaria; **Application site disorders:** Cellulitis, dermatitis contact, injection site reaction, skin nodule; **Special senses:** Taste perversion; **Urinary system:** Albuminuria, cystitis, dysuria, hematuria, micturition frequency, renal calculus, urinary incontinence, urinary tract infection; **Vision:** Blurred vision, cataract, conjunctivitis, eye pain, glaucoma.

Other serious adverse reactions which occur rarely (estimated < 0.1%), regardless of causality: Cases reported only in the post-marketing experience are indicated in italics. **Cardiovascular:** Syncope, congestive heart failure, ventricular fibrillation, pulmonary embolism, cerebrovascular accident, peripheral gangrene, thrombophlebitis, vasculitis; **GI:** Intestinal obstruction, intestinal perforation, GI bleeding, colitis with bleeding, esophageal perforation, pancreatitis, ileus; **Liver and biliary system:** Cholelithiasis, hepatitis, jaundice, liver failure; **Hemic and lymphatic:** Thrombocytopenia, agranulocytosis, aplastic anemia, pancytopenia, leukopenia; **Metabolic:** Hypoglycemia, hyponatremia; **Nervous system:** Aseptic meningitis, ataxia, suicide; **Renal:** Acute renal failure, interstitial nephritis; **Skin:** Erythema multiforme, exfoliative dermatitis, Stevens-Johnson syndrome, toxic epidermal necrolysis; **General:** Sepsis, sudden death, anaphylactoid reaction, angioedema.

Safety Data from CLASS Study:

Hematological Events:

During this study (see Special Studies - Use with Aspirin), the incidence of clinically significant decreases in hemoglobin (>2 g/dL) confirmed by repeat testing was lower in patients on CELEBREX 400 mg BID (4-fold and 2-fold the recommended OA and RA doses, respectively) compared to patients on either diclofenac 75 mg BID or ibuprofen 800 mg TID: 0.5%, 1.3% and 1.9%, respectively. The lower incidence of events with CELEBREX was maintained with or without ASA use (see CLINICAL STUDIES - Special Studies - Platelets).

Withdrawals/Serious Adverse Events:

Kaplan-Meier cumulative rates at 9 months for withdrawals due to adverse events for CELEBREX, diclofenac and ibuprofen were 24%, 29%, and 26%, respectively. Rates for serious adverse events regardless of causality were not different across treatment groups, respectively, 8%, 7%, and 8%.

Based on Kaplan-Meier cumulative rates for investigator-reported serious cardiovascular thromboembolic adverse events (includes myocardial infarction, pulmonary embolism, deep venous thrombosis, unstable angina, transient ischemic attacks or ischemic cerebrovascular accidents), there were no differences between the CELEBREX, diclofenac, or ibuprofen treatment groups. The rates in all patients at 9 months for CELEBREX, diclofenac, and ibuprofen were 1.2%, 1.4%, and 1.1%, respectively. The rates for non-ASA users in each of the three treatment groups were less than 1%. The rates for myocardial infarction in each of the three non-ASA treatment groups were less than 0.2%.

Adverse events from analgesia and dysmenorrhea studies: About 1,700 patients were treated with CELEBREX in analgesia and dysmenorrhea studies. All patients in post-oral surgery pain studies received a single dose of study medication. Doses up to 600 mg/day of CELEBREX were studied in primary dysmenorrhea and post-orthopedic surgery pain studies. The types of adverse events in the analgesia and dysmenorrhea studies were similar to those reported in arthritis studies. The only additional adverse event reported was post-dental extraction alveolar osteitis (dry socket) in the post-oral surgery pain studies.

OVERDOSAGE

Doses up to 2400 mg/day for up to 3 days in 3 patients did not result in serious toxicity. Symptoms following acute NSAID overdoses are usually limited to lethargy, drowsiness, nausea, vomiting, and epigastric pain, which are generally reversible with supportive care. GI bleeding can occur. Hypertension, acute renal failure, respiratory depression and coma may occur, but are rare. Anaphylactoid reactions have been reported with therapeutic ingestion of NSAIDs, and may occur following an overdose. Manage patients by symptomatic and supportive care following an overdose. There are no specific antidotes. Dialysis is unlikely to be useful. Emesis and/or activated charcoal (60 to 100 g in adults, 1 to 2 g/kg in children) and/or osmotic cathartic may be indicated in patients seen within 4 hours of ingestion with symptoms or following a large overdose. Forced diuresis, alkalization of urine, hemodialysis, or hemoperfusion may not be useful.

DOSAGE AND ADMINISTRATION

Osteoarthritis: 200 mg QD or 100 mg BID.

Rheumatoid arthritis: 100 or 200 mg BID.

Acute Pain and Primary Dysmenorrhea: 400 mg initially followed by an additional 200 mg dose if needed on the first day. On subsequent days, 200 mg BID.

Hepatic Insufficiency: Reduce daily dosage by 50% for patients with moderate hepatic impairment (Child-Pugh Class B).

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August 2002

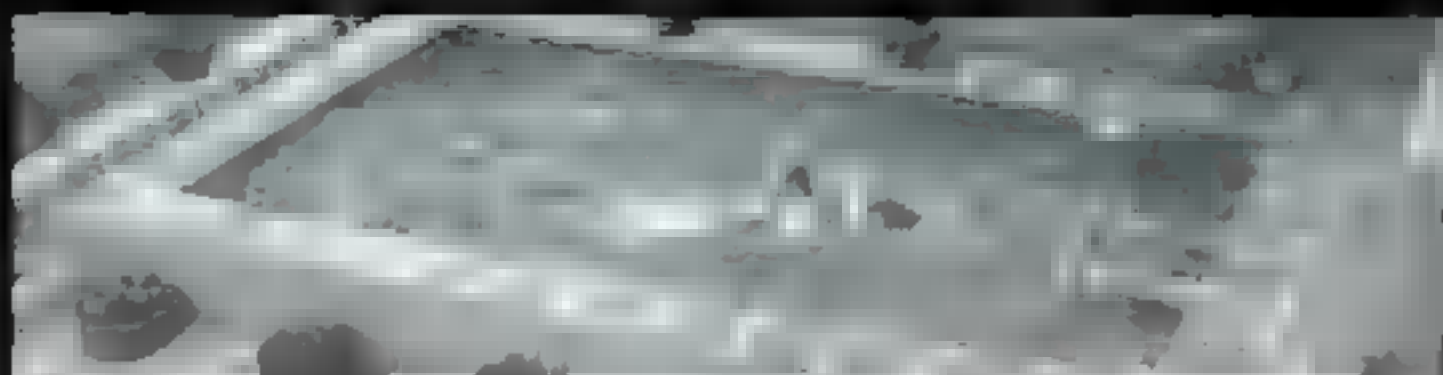
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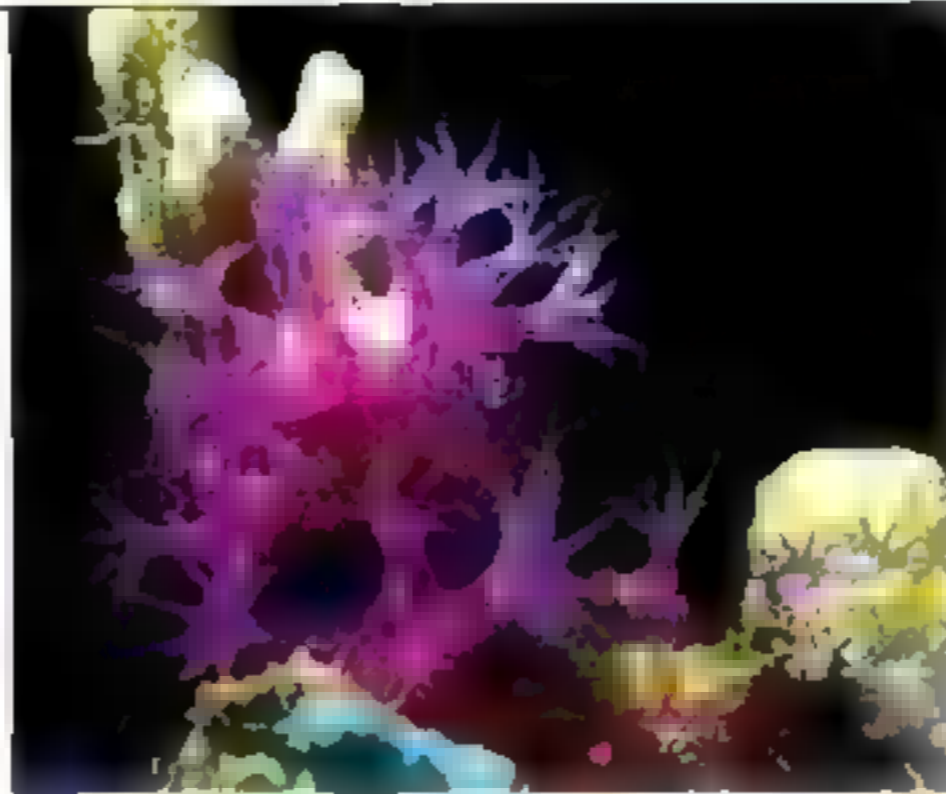
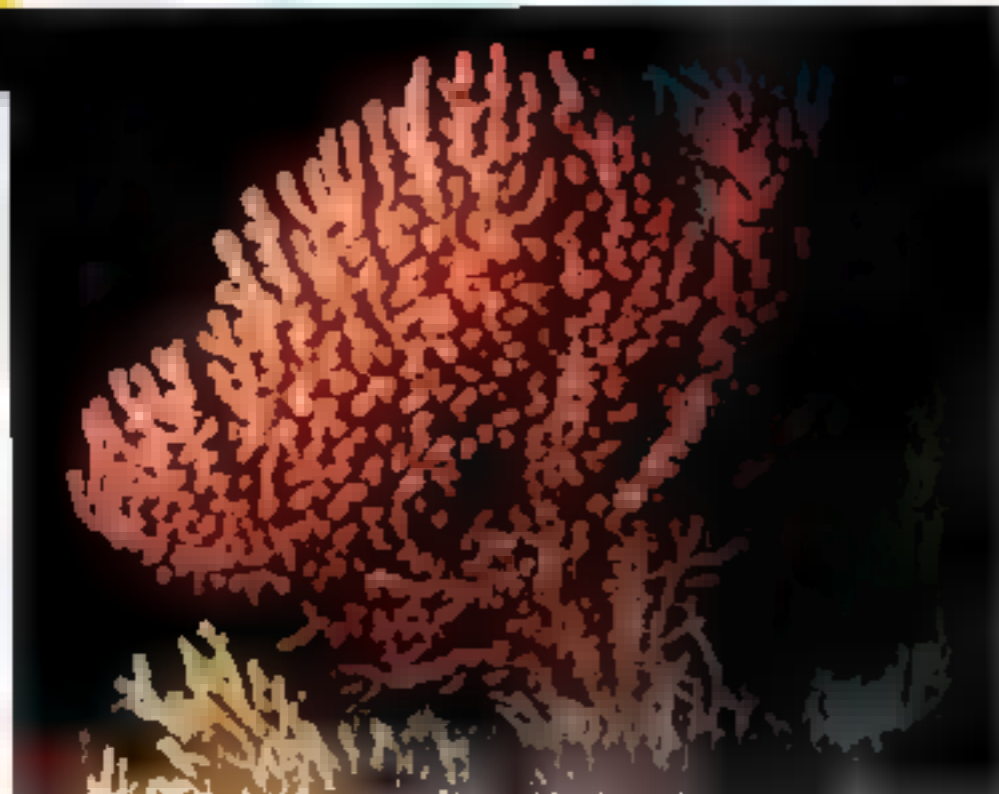
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BOTH BY A. FREIWALD, PALEONTOLOGY ERLANGEN

CONSERVATION

Coral Reefs Down Deep

The glories of coral reefs, it turns out, are not confined to shallow tropical seas. In recent years marine biologists have discovered extensive deepwater corals, some as far down as 6,500 feet, in the North

Atlantic, from Norway south to the Azores. Unlike tropical coral polyps, which have algae in their tissues that need sunlight for photosynthesis, these polyps are filter feeders, trapping whatever goes by. Like tropical reefs,

these deepwater communities are magnets for marine life, and scientists have identified nearly 900 species that inhabit them.

Some of the deep beds were discovered when fishermen reported pieces of coral in their trawl nets. To protect the reefs, Norway has banned trawling on five reefs in its waters, including the 8,600-year-old Sula Reef, home to *Paragorgia arborea* (far left) and *Anthothela grandiflora* (left). "The ban benefits fisheries in the long run because trawling destroys the kindergarten of the fish," says André Freiwald of Germany's University of Erlangen.

—John L. Eliot

WHAT IS IT?

A hockey-puck-size oak disk that some think could be a Viking sun compass.

What's a sun compass?

A navigational device. Like a sundial, it uses a central pin to cast a shadow onto a dial, indicating the altitude of the sun. (The pin in the photo has been added to the original disk to show how the compass might work.) Matching the shadow's movements to markings on the dial helps the user follow a specific direction.

Who used sun compasses?

Fourteenth-century Syrians devised some simple versions. In the 1930s the British used them to navigate Egyptian deserts.

Any evidence that Vikings had sun compasses?

In 1948 an archaeologist unearthed part of a disk amid the ruins of a Norse settlement in Greenland. Like the disk pictured here, which was found in a medieval dig on Wolin, a Baltic island off western Poland, it lacked a central pin.



PHOTO: SKURVICKI

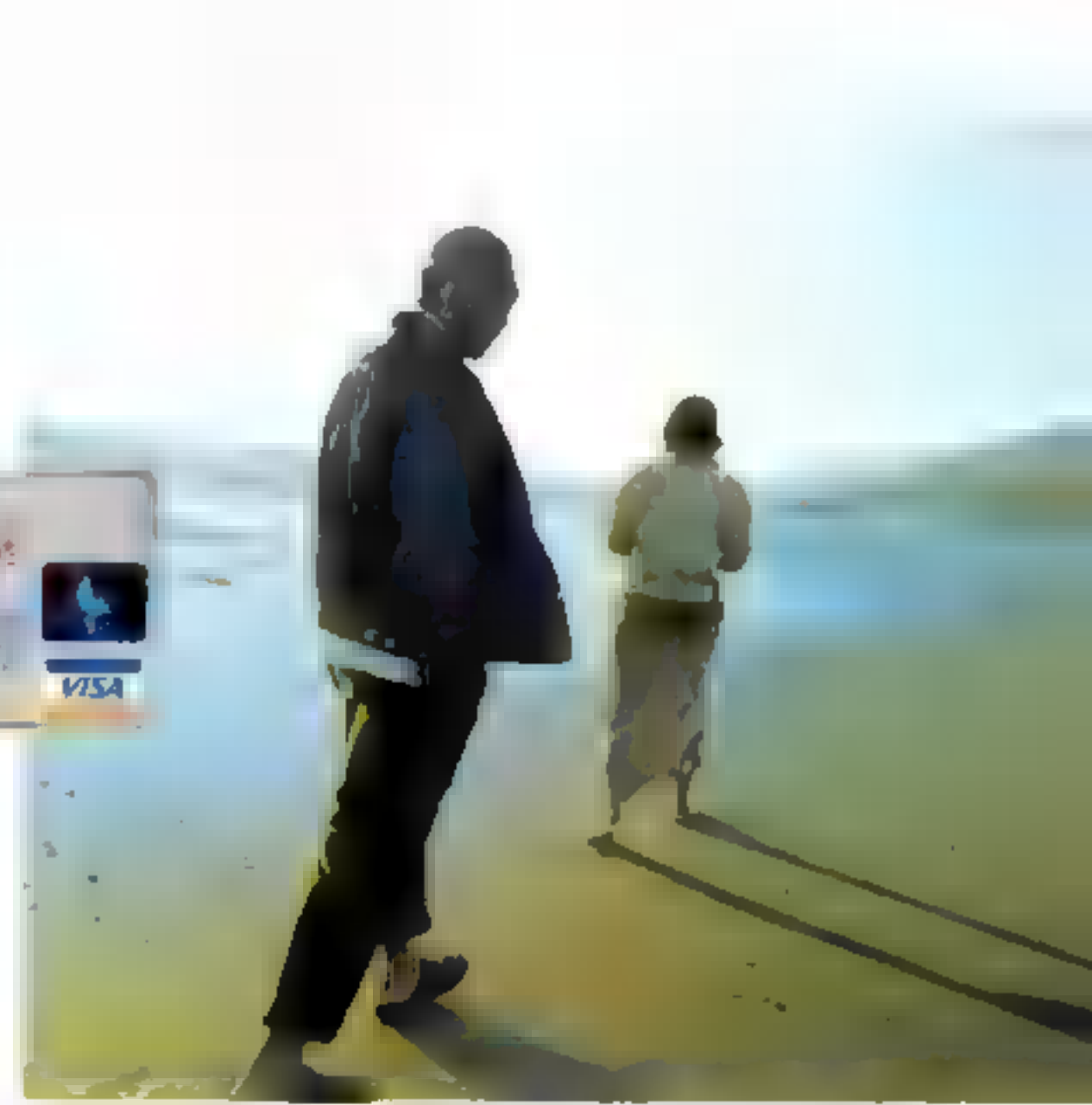
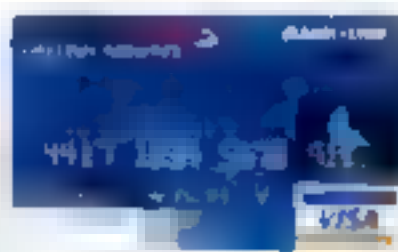
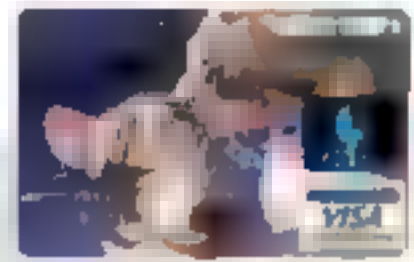
Did Lief Eriksson use a sun compass to find North America?

Historians aren't sure how he and Erik the Red, his father, navigated on their far-ranging explorations two centuries before magnetic compasses appeared. Norse sagas say mariners watched for whales and birds to locate land.

And if it isn't a sun compass?

Maybe it's a game piece or part of a child's toy, as some Norse experts have explained the Greenland find. But for now, the ancient riddle persists: On the open water, with neither fish nor fowl in sight, how did a wayward Viking find his way? —Peter Gwin

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CHRIS JOHNS/NGS

ZOOLOGY

By the Light of the Moon

Beetles stay on course using lunar navigation

Like sailors navigating with a sextant, some bees, ants, spiders, and birds use sunlight to orient themselves. But African dung beetles are much more sensitive: They can steer by moonlight, a mere one-millionth the sun's brightness.

The beetles, *Scarabaeus zambesianus*, don't use the moon directly but rather its polarized light. When moonlight strikes air molecules in Earth's atmosphere, the rays scatter into planes that point in different directions. It's this grid of polarized light that guides the beetles.

At sunset the beetles vie for fresh antelope or warhog dung—their main food. Each insect makes a dung ball and quickly rolls it away from the others, walking backward with its head down and rolling with its hind legs. "This allows the parts of its eyes that are sensitive to polarized light to view the sky," says biologist Marie Dacke of Sweden's University of Lund. By using the polarized moonlight, each beetle can keep its ball rolling in a straight line and thus avoid bumping into competitor beetles. On moonless

nights the beetles don't forage, but in experiments simulating such nights "they weave randomly and steal each others' dung balls," Dacke says.

Once back at their burrows, the beetles feast for days. In some species females lay eggs in the dung, so the hatched larvae can feed on it. —John L. Eliot

It Must Be the Moon

Moon myths about fantastic creatures like werewolves abound, but some animals really do respond to lunar phases and the moon's effect on the tides.

Coral polyps on the Great Barrier Reef spawn after the full moon in October or November, creating a blizzard of eggs and sperm.

Horseshoe crabs mate along the coast of North America on the full and new moons in May or June.

Grunion fish beach themselves to spawn on California shores a few nights after the full or new moons, from late February to September.

Some moths are drawn skyward by moonlight and travel long distances on low jet streams.

EATS



Maya Treat: Not So Sweet

Tastes change, even when it comes to chocolate. The Maya often liked their chocolate unsweetened and mixed with water into a frothy drink. A vessel dated A.D. 700 (below) shows a woman pouring the chocolate mix to make foam, the Maya's favorite part. Some Maya today still whip up this old-style, bitter beverage.

The Maya may also have used chocolate—symbolized in the 1,500-year-old glyph above—to flavor their food. Archaeologists led by Robert Sharer of the University of Pennsylvania have found chocolate residue on a ceramic platter (from an early mole sauce?) and in a bowl with fish bones in tombs at Copán in Honduras dating from A.D. 400 to 600.

Since cacao plants—chocolate's source—thrive in many parts of the Maya world, some scholars think the treat was enjoyed not just by royalty, as long believed, but by regular joes as well.

—Jennifer Steinberg Holland



GEORGE F. MOBLEY (TOP); BRUCE M. WHITE, PRINCETON UNIVERSITY ART MUSEUM



Golden-crowned Sifaka (*Propithecus tattersalli*)

Size: Head and body length, 50 cm; tail, 40 cm **Weight:** 3.5 kg

Habitat: Deciduous and semi-evergreen forests between the Loky and Manambato Rivers of northeastern Madagascar **Surviving number:** Estimated at 6,000-8,000



Photographed by Antonio Sabater

WILDLIFE AS CANON SEES IT

Humans generally make lousy neighbors. There are some exceptions, however. When prospectors moved into the forest in search of gold they found an unexpected treasure: golden-crowned sifakas. These little creatures won the humans' hearts with their striking looks and acrobatic displays; rather than hunting or otherwise disturbing them, the prospectors fed them bananas every day. Unmolested, the sifakas went about their

business—groups of three to 10 scouring the treetops for fruit, leaves, flowers and seeds. Despite meeting some humans with hearts of gold, sifakas are still under threat as their forest habitat disappears.

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A large, green frog is perched on top of a large, white battery cell. The frog is looking towards the camera. The battery cell is part of a larger structure that looks like a building or a platform. The background is a soft, out-of-focus green.

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JOE McNALLY (ABOVE); BILL DOUTHITT, NGS (BELOW LEFT)

First Digital Assignment Flies

Speed of new technology lands the story

This issue's cover story—celebrating 100 years of flight by highlighting the latest in aviation—was almost derailed by the war in Iraq. The military's most advanced bomber, the batlike B-2 (pages 2-3), was critical to our coverage, but also critical to the war. Scheduling time to photograph the bomber started to seem impossible. But Joe McNally persisted, and he finally got his shot.



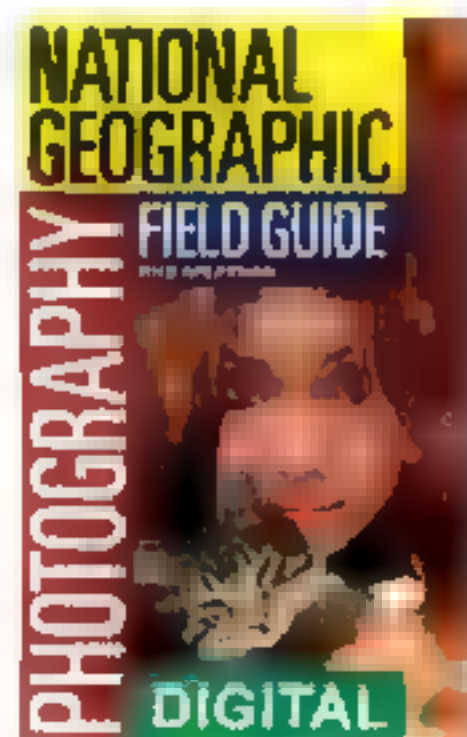
The day before his deadline, Joe received permission to digitally photograph a B-2 as it was being prepped for a training mission. The next morning, he rushed to our Washington, D.C., headquarters, digital memory chip in hand. He and picture editor Bill Douthitt downloaded the images and chose the lead picture for the story (below, Bill at right). "We wouldn't have made our deadline if we had had to process film," says Bill, adding, "This was the first major story we decided to shoot digitally from the beginning."

The subject warranted it: Joe and his assistants, posing above on an SR-71 Blackbird (Joe at right) could see almost immediately whether images taken, say,

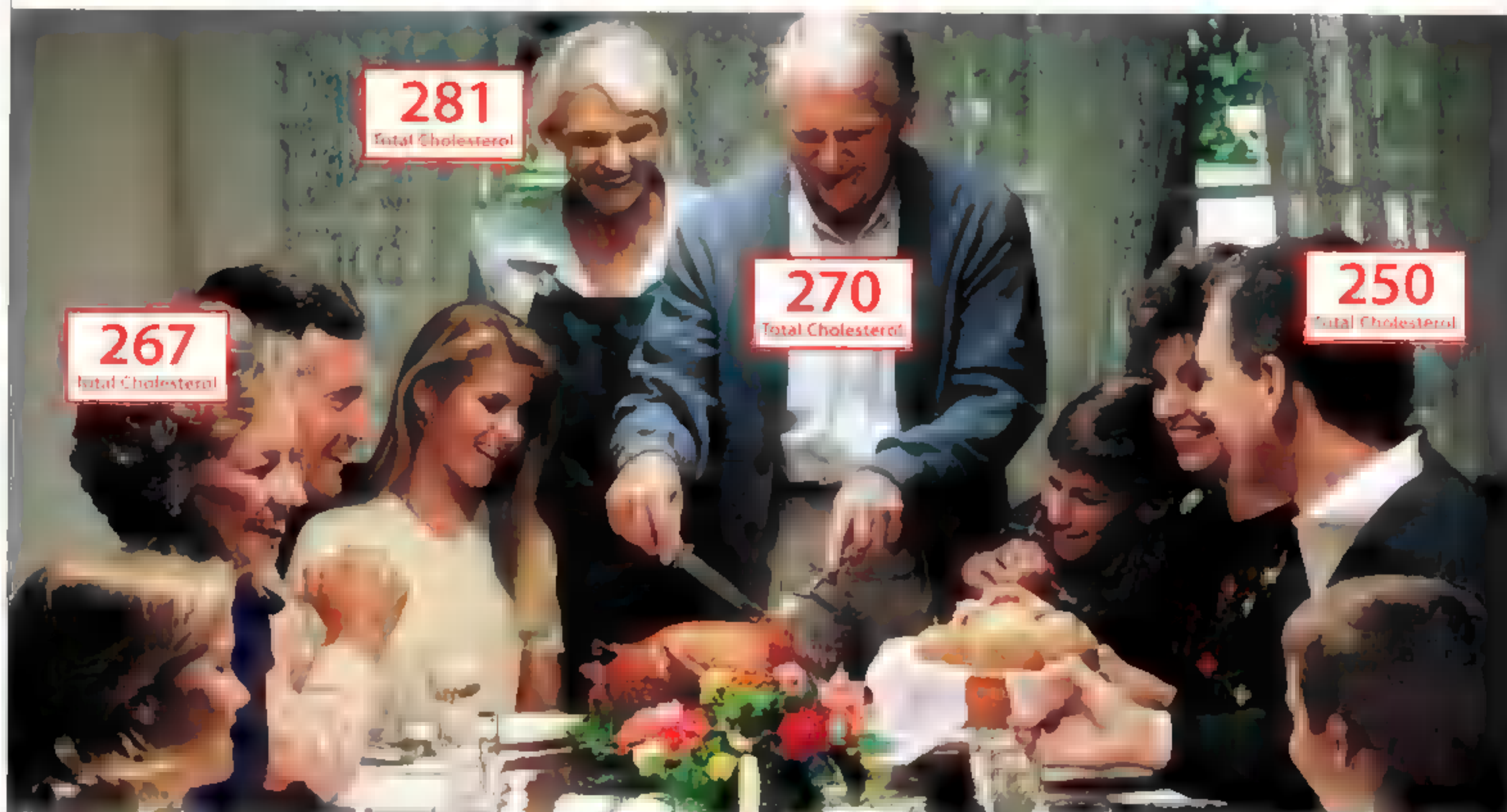
from a plunging F-16, had worked. And military security could monitor photos of sensitive subjects right on Joe's laptop. "If not for instant imaging, we would have had to surrender film to the military for processing," says Joe. "Not ideal."

Digital Photography

Their popularity soaring, digital cameras are expected to outsell traditional film cameras this year in the U.S. But what does it take to make good pictures with them? Professionals offer insights and tips to the new technology in *National Geographic Photography Field Guide: Digital* (\$21.95). Available at bookstores or at nationalgeographic.com.



Some family traditions we can live without.



Take high cholesterol. Anyone can have it. Here's something else you might not know. About one-fifth of your cholesterol comes from what you eat. That's because high cholesterol often has as much to do with family genes as food. So, even if you diet and exercise you may need some help to lower it. The good news is that adding LIPITOR can help. It can lower your total cholesterol 29% to 45%*. And it can lower your bad cholesterol 39% to 60%*. (*The average effect depends on the dose.) Ask your doctor if it's right for you. Of all cholesterol medicines, doctors prescribe LIPITOR the most. Learn more. Call us at 1-888-LIPITOR or find us on the web at www.lipitor.com.

 **LIPITOR.**
atorvastatin calcium
tablets
FOR CHOLESTEROL*

Important information:

LIPITOR[®] (atorvastatin calcium) is a prescription drug used with diet to lower cholesterol. LIPITOR is not for everyone, including those with liver disease or possible liver problems, women who are nursing, pregnant, or may become pregnant. LIPITOR has not been shown to prevent heart disease or heart attacks.

If you take LIPITOR, tell your doctor about any unusual muscle pain or weakness. This could be a sign of serious side effects. It is important to tell your doctor about any medications you are currently taking to avoid possible serious drug interactions. Your doctor may do simple blood tests to monitor liver function before and during drug treatment. The most commonly reported side effects are gas, constipation, stomach pain and indigestion. They are usually mild and tend to go away.

Please see additional important information on next page.

LIPITOR® (Atorvastatin Calcium) Tablets
Brief Summary of Prescribing Information

CONTRAINDICATIONS: Active liver disease or unexplained persistent elevations of serum transaminases. Hypersensitivity to any component of this medication. **Pregnancy and Lactation** — Atherosclerosis is a chronic process and discontinuation of lipid-lowering drugs during pregnancy should have little impact on the outcome of long-term therapy of primary hypercholesterolemia. Cholesterol and other products of cholesterol biosynthesis are essential components for fetal development (including synthesis of steroids and cell membranes). Since HMG-CoA reductase inhibitors decrease cholesterol synthesis and possibly the synthesis of other biologically active substances derived from cholesterol, they may cause fetal harm when administered to pregnant women. Therefore, HMG-CoA reductase inhibitors are contraindicated during pregnancy and in nursing mothers. ATORVASTATIN SHOULD BE ADMINISTERED TO WOMEN OF CHILD-BEARING AGE ONLY WHEN SUCH PATIENTS ARE HIGHLY UNLIKELY TO CONCEIVE AND HAVE BEEN INFORMED OF THE POTENTIAL HAZARDS. If the patient becomes pregnant while taking this drug, therapy should be discontinued and the patient apprised of the potential hazard to the fetus.

WARNINGS: Liver Dysfunction — HMG-CoA reductase inhibitors, like some other lipid-lowering therapies, have been associated with biochemical abnormalities of liver function. **Persistent elevations (>3 times the upper limit of normal [ULN]) occurring on 2 or more occasions in serum transaminases occurred in 0.7% of patients who received atorvastatin in clinical trials. The incidence of these abnormalities was 0.2%, 0.2%, 0.6%, and 2.3% for 10, 20, 40, and 80 mg, respectively.** One patient in clinical trials developed jaundice. Increases in liver function tests (LFT) in other patients were not associated with jaundice or other clinical signs or symptoms. Upon dose reduction, drug interruption, or discontinuation, transaminase levels returned to or near pretreatment levels without sequelae. Eighteen of 30 patients with persistent LFT elevations continued treatment with a reduced dose of atorvastatin. It is recommended that liver function tests be performed prior to and at 12 weeks following both the initiation of therapy and any elevation of dose, and periodically (eg, semiannually) thereafter. Liver enzyme changes generally occur in the first 3 months of treatment with atorvastatin. Patients who develop increased transaminase levels should be monitored until the abnormalities resolve. Should an increase in ALT or AST of >3 times ULN persist, reduction of dose or withdrawal of atorvastatin is recommended. Atorvastatin should be used with caution in patients who consume substantial quantities of alcohol and/or have a history of liver disease. Active liver disease or unexplained persistent transaminase elevations are contraindications to the use of atorvastatin (see CONTRAINDICATIONS).

Skeletal Muscle — Rare cases of rhabdomyolysis with acute renal failure secondary to myoglobinuria have been reported with atorvastatin and with other drugs in this class. Uncomplicated myalgia has been reported in atorvastatin-treated patients (see ADVERSE REACTIONS). Myopathy, defined as muscle aches or muscle weakness in conjunction with increases in creatine phosphokinase (CPK) values >10 times ULN, should be considered in any patient with diffuse myalgias, muscle tenderness or weakness, and/or marked elevation of CPK. Patients should be advised to report promptly unexplained muscle pain, tenderness or weakness, particularly if accompanied by malaise or fever. Atorvastatin therapy should be discontinued if markedly elevated CPK levels occur or myopathy is diagnosed or suspected. The risk of myopathy during treatment with drugs in this class is increased with concurrent administration of cyclosporine, fibric acid derivatives, erythromycin, niacin, or azole antifungals. Physicians considering combined therapy with atorvastatin and fibric acid derivatives, erythromycin, immunosuppressive drugs, azole antifungals, or lipid-lowering doses of niacin should carefully weigh the potential benefits and risks and should carefully monitor patients for any signs or symptoms of muscle pain, tenderness, or weakness, particularly during the initial months of therapy and during any periods of upward dosage titration of either drug. Periodic creatine phosphokinase (CPK) determinations may be considered in such situations, but there is no assurance that such monitoring will prevent the occurrence of severe myopathy. Atorvastatin therapy should be temporarily withheld or discontinued in any patient with an acute, serious condition suggestive of a myopathy or having a risk factor predisposing to the development of renal failure secondary to rhabdomyolysis (eg, severe acute infection, hypotension, major surgery, trauma, severe metabolic, endocrine and electrolyte disorders, and uncontrolled seizures).

PRECAUTIONS: General — Before instituting therapy with atorvastatin, an attempt should be made to control hypercholesterolemia with appropriate diet, exercise, and weight reduction in obese patients, and to treat other underlying medical problems (see INDICATIONS AND USAGE in full prescribing information).

Information for Patients — Patients should be advised to report promptly unexplained muscle pain, tenderness, or weakness, particularly if accompanied by malaise or fever. **Drug Interactions** — The risk of myopathy during treatment with drugs of this class is increased with concurrent administration of cyclosporine, fibric acid derivatives, niacin (nicotinic acid), erythromycin, azole antifungals (see WARNINGS, Skeletal Muscle).

Antacid: When atorvastatin and Maalox® TC suspension were coadministered, plasma concentrations of atorvastatin decreased approximately 35%. However, LDL-C reduction was not altered. **Aspirin:** Because atorvastatin does not affect the pharmacokinetics of aspirin, interactions with other drugs metabolized via the same cytochrome isozymes are not expected. **Colestipol:** Plasma concentrations of atorvastatin decreased approximately 25% when colestipol and atorvastatin were coadministered. However, LDL-C reduction was greater when atorvastatin and colestipol were coadministered than when either drug was given alone.

Cimetidine: Atorvastatin plasma concentrations and LDL-C reduction were not altered by coadministration of cimetidine. **Digoxin:** When multiple doses of atorvastatin and digoxin were coadministered, steady-state plasma digoxin concentrations increased by approximately 20%. Patients taking digoxin should be monitored appropriately. **Erythromycin:** In healthy individuals, plasma concentrations of atorvastatin increased approximately 48% with coadministration of atorvastatin and erythromycin, a known inhibitor of cytochrome P450 3A4 (see WARNINGS, Skeletal Muscle). **Oral Contraceptives:** Coadministration of atorvastatin and an oral contraceptive increased AUC values for norethindrone and ethinyl estradiol by approximately 30% and 20%. These increases should be considered when selecting an oral contraceptive for a woman taking atorvastatin.

Warfarin: Atorvastatin had no clinically significant effect on prothrombin time when administered to patients receiving chronic warfarin treatment. **Endocrine Function** — HMG-CoA reductase inhibitors interfere with cholesterol synthesis and theoretically might blunt adrenal and/or gonadal steroid production. Clinical studies have shown that atorvastatin does not reduce basal plasma cortisol concentration or impair adrenal reserve. The effects of HMG-CoA reductase inhibitors on male fertility have not been studied in adequate numbers of patients. The effects, if any, on the pituitary-gonadal axis in premenopausal women are unknown. Caution should be exercised if an HMG-CoA reductase inhibitor is administered concomitantly with drugs that may decrease the levels or activity of endogenous steroid hormones, such as ketoconazole, spironolactone, and cimetidine. **CNS Toxicity** — Brain hemorrhage was seen in a female dog treated for 3 months at 120 mg/kg/day. Brain hemorrhage and optic nerve vacuolation were seen in another female dog that was sacrificed in moribund condition after 11 weeks of escalating doses up to 280 mg/kg/day. The 120 mg/kg dose resulted in a systemic exposure approximately 16 times the human plasma area-under-the-curve (AUC, 0-24 hours) based on the maximum human dose of 80 mg/day. A single tonic convulsion was seen in each of 2 male dogs (one treated at 10 mg/kg/day and one at 120 mg/kg/day) in a 2-year study. No CNS lesions have been observed in mice after chronic treatment for up to 2 years at doses up to 400 mg/kg/day or in rats at doses up to 100 mg/kg/day. These doses were 6 to 11 times (mouse) and 8 to 16 times (rat) the human AUC (0-24 hours) based on the maximum recommended human dose of 80 mg/day. CNS vascular lesions, characterized by perivascular hemorrhages, edema, and mononuclear cell infiltration of perivascular spaces, have been observed in dogs treated with other members of this class. A chemically similar drug in this class produced optic nerve degeneration (Wallerian degeneration of retinogeniculate fibers) in clinically normal dogs in a dose-dependent fashion at a dose that produced plasma drug levels about 30 times higher than the mean drug level in humans taking the highest recommended dose.

Carcinogenesis, Mutagenesis, Impairment of Fertility — In a 2-year carcinogenicity study in rats at dose levels of 10, 30, and 100 mg/kg/day, 2 rare tumors were found in muscle in high-dose females: in one, there was a rhabdomyosarcoma and, in another, there was a fibrosarcoma. This dose represents a plasma AUC (0-24) value of approximately 89 times the mean human plasma drug exposure after an 80 mg oral dose. A 2-year carcinogenicity study in mice given 100, 200, or 400 mg/kg/day resulted in a significant increase in liver adenomas in high-dose males and liver carcinomas in high-dose females. These findings occurred at plasma AUC (0-24) values of approximately 6 times the mean human plasma drug exposure after an 80 mg oral dose. *In vitro*, atorvastatin was not mutagenic or clastogenic in the following tests with and without metabolic activation: the Ames test with *Salmonella typhimurium* and *Escherichia coli*, the HGPRT forward mutation assay in Chinese hamster lung cells, and the chromosomal aberration assay in Chinese hamster lung cells. Atorvastatin was negative in the *in vivo* mouse micronucleus test. Studies in rats performed at doses up to 175 mg/kg (15 times the human exposure) produced no changes in fertility. There was aplasia and aspermia in the epididymus of 2 of 10 rats treated with 100 mg/kg/day of atorvastatin for 3 months (16 times the human AUC at the 80 mg dose); testis weights were significantly lower at 39 and 100 mg/kg and epididymal weight was lower at 100 mg/kg. Male rats given 100 mg/kg/day for 11 weeks prior to mating had decreased sperm motility, sperm head concentration, and increased abnormal sperm. Atorvastatin caused no adverse effects on semen parameters, or reproductive organ histopathology in dogs given doses of 10, 40, or 120 mg/kg for two years. **Pregnancy** — **Pregnancy Category X.** See CONTRAINDICATIONS. Safety in pregnant women has not been established. Atorvastatin crosses the rat placenta and reaches a level in fetal liver equivalent to that of maternal plasma. Atorvastatin was not teratogenic in rats at doses up to 300 mg/kg/day or in rabbits at doses up to 100 mg/kg/day. These doses resulted in multiples of about 30 times (rat) or 20 times (rabbit) the human exposure based on surface area (mg/m²). In a study in rats given 20, 100, or 285 mg/kg/day, from gestation day 7 through to lactation day 21 (weaning), there was decreased pup survival at birth, neonatal, weaning, and maturity in pups of mothers dosed with 225 mg/kg/day. Body weight was decreased on days 4 and 21 in pups of mothers dosed at 100 mg/kg/day; pup body weight was decreased at birth and at days 4, 21, and 91 at 225 mg/kg/day. Pup development was delayed (rotarod performance at 100 mg/kg/day and acoustic startle at 225 mg/kg/day, pinnae detachment and eye opening at 225 mg/kg/day). These doses correspond to 6 times (100 mg/kg) and 22 times (225 mg/kg) the human AUC at 80 mg/day. Rare reports of congenital anomalies have been received following intrauterine exposure to HMG-CoA reductase inhibitors. There has been one report of severe congenital bony deformity, tracheo-esophageal fistula, and anal atresia (VATER association) in a baby born to a woman who took lovastatin with dextroamphetamine sulfate during the first trimester of pregnancy. LIPITOR

should be administered to women of child-bearing potential only when such patients are highly unlikely to conceive and have been informed of the potential hazards. If the woman becomes pregnant while taking LIPITOR, it should be discontinued and the patient advised again as to the potential hazards to the fetus. **Nursing Mothers** — Nursing rat pups had plasma and liver drug levels of 50% and 40%, respectively, of that in their mother's milk. Because of the potential for adverse reactions in nursing infants, women taking LIPITOR should not breast-feed (see CONTRAINDICATIONS). **Pediatric Use** — Safety and effectiveness in patients 10-17 years of age with heterozygous familial hypercholesterolemia have been evaluated in controlled clinical trials of 6 months duration in adolescent boys and postmenarcheal girls. Patients treated with LIPITOR had an adverse experience profile generally similar to that of patients treated with placebo, the most common adverse experiences observed in both groups, regardless of causality assessment, were infections. **Doses greater than 20 mg have not been studied in this patient population.** In this limited controlled study, there was no detectable effect on growth or sexual maturation in boys or on menstrual cycle length in girls. See CLINICAL PHARMACOLOGY, Clinical Studies section in full prescribing information. **ADVERSE REACTIONS, Pediatric Patients, and DOSAGE AND ADMINISTRATION, Pediatric patients (10-17 years of age) with Heterozygous Familial Hypercholesterolemia** in full prescribing information. Adolescent females should be counseled on appropriate contraceptive methods while on LIPITOR therapy (see CONTRAINDICATIONS and PRECAUTIONS, Pregnancy). LIPITOR has not been studied in controlled clinical trials involving pre-pubertal patients or patients younger than 10 years of age. Clinical efficacy with doses up to 80 mg/day for 1 year have been evaluated in an uncontrolled study of patients with homozygous FH including 8 pediatric patients. See CLINICAL PHARMACOLOGY, Clinical Studies in Homozygous Familial Hypercholesterolemia in full prescribing information. **Geriatric Use** — The safety and efficacy of atorvastatin (10-80 mg) in the geriatric population (≥65 years of age) was evaluated in the ACCESS study. In this 54-week open-label trial, 1,958 patients initiated therapy with atorvastatin 10 mg. Of these, 835 were elderly (≥65 years) and 1,123 were non-elderly. The mean change in LDL-C from baseline after 8 weeks of treatment with atorvastatin 10 mg was -38.2% in the elderly patients versus -34.6% in the non-elderly group. The rates of discontinuation due to adverse events were similar between the two age groups. There were no differences in clinically relevant laboratory abnormalities between the age groups.

ADVERSE REACTIONS: LIPITOR is generally well-tolerated. Adverse reactions have usually been mild and transient. In controlled clinical studies of 2502 patients, <2% of patients were discontinued due to adverse experiences attributable to atorvastatin. The most frequent adverse events thought to be related to atorvastatin were constipation, flatulence, dyspepsia, and abdominal pain. **Clinical Adverse Experiences** — Adverse experiences reported in ≥2% of patients in placebo-controlled clinical studies of atorvastatin, regardless of causality assessment, are shown in the following table.

Adverse Events in Placebo-Controlled Studies (% of Patients)					
BODY SYSTEM	Placebo N = 270	Atorvastatin 10 mg N = 963	Atorvastatin 20 mg N = 36	Atorvastatin 40 mg N = 79	Atorvastatin 80 mg N = 94
BODY AS A WHOLE					
Infection	10.0	10.3	2.8	10.1	7.4
Headache	7.0	5.4	16.7	2.5	6.4
Accidental Injury	3.7	4.2	0.0	1.3	3.2
Flu Syndrome	1.9	2.2	0.0	2.5	3.2
Abdominal Pain	0.7	2.8	0.0	3.8	2.1
Back Pain	3.0	2.8	0.0	3.8	1.1
Allergic Reaction	2.6	0.9	2.8	1.3	0.0
Asthenia	1.9	2.2	0.0	0.0	0.0
DIGESTIVE SYSTEM					
Constipation	1.8	2.1	0.0	2.5	1.1
Diarrhea	1.5	2.7	0.0	3.8	5.3
Dyspepsia	4.1	2.3	2.8	1.3	2.1
Flatulence	3.3	2.1	2.8	1.3	1.1
RESPIRATORY SYSTEM					
Sinusitis	2.6	2.8	0.0	2.5	6.4
Pharyngitis	1.5	2.5	0.0	1.3	2.1
SKIN AND APPENDAGES					
Rash	0.7	3.9	2.8	3.8	1.1
MUSCULOSKELETAL SYSTEM					
Arthralgia	1.5	2.0	0.0	5.1	0.0
Myalgia	1.1	3.2	5.6	1.3	0.0

The following adverse events were reported, regardless of causality assessment in patients treated with atorvastatin in clinical trials. The events in italics occurred in ≥2% of patients and the events in plain type occurred in <2% of patients.

Body as a Whole: Chest pain, face edema, fever, neck rigidity, malaise, photosensitivity reaction, generalized edema. **Digestive System:** Nausea, gastroenteritis, liver function tests abnormal, colitis, vomiting, gastritis, dry mouth, rectal hemorrhage, esophagitis, eructation, glossitis, mouth ulceration, anorexia, increased appetite, stomatitis, biliary pain, cholelithiasis, duodenal ulcer, dysphagia, enteritis, melena, gum hemorrhage, stomach ulcer, tenosimus, ulcerative stomatitis, hepatitis, pancreatitis, cholelithiasis, jaundice. **Respiratory System:** Bronchitis, rhinitis, pneumonia, dyspnea, asthma, epistaxis. **Nervous System:** Insomnia, dizziness, paresthesia, somnolence, amnesia, abnormal dreams, libido decreased, emotional lability, incoordination, peripheral neuropathy, tonic-clonic, facial paralysis, hyperkinesia, depression, hyposthesia, hypotonia. **Musculoskeletal System:** Arthritis, leg cramps, bursitis, tenosynovitis, myasthenia, tendinous contracture, myositis. **Skin and Appendages:** Pruritus, contact dermatitis, alopecia, dry skin, sweating, acne, urticaria, eczema, seborrhea, skin ulcer. **Urogenital System:** Urinary tract infection, urinary frequency, cystitis, hematuria, impotence, dysuria, kidney calculus, nocturia, epididymitis, fibrocystic breast, vaginal hemorrhage, albuminuria, breast enlargement, metrorrhagia, nephritis, urinary incontinence, urinary retention, urinary urgency, abnormal ejaculation, uterine hemorrhage. **Special Senses:** Amblyopia, tinnitus, dry eyes, refraction disorder, eye hemorrhage, deafness, glaucoma, parosmia, taste loss, taste perversion. **Cardiovascular System:** Palpitation, vasodilation, syncope, migraine, postural hypotension, phlebitis, arrhythmia, angina pectoris, hypertension. **Metabolic and Nutritional Disorders:** Peripheral edema, hyperglycemia, creatine phosphokinase increased, gout, weight gain, hypoglycemia. **Hemic and Lymphatic System:** Echinomiasis, anemia, lymphadenopathy, thrombocytopenia, petechia. **Postintroduction Reports** — Adverse events associated with LIPITOR therapy reported since market introduction, that are not listed above, regardless of causality assessment, include the following: anaphylaxis, angioneurotic edema, bullous rashes including erythema multiforme, Stevens-Johnson syndrome, and toxic epidermal necrolysis, and rhabdomyolysis. **Pediatric Patients (ages 10-17 years)** In a 26-week controlled study in boys and postmenarcheal girls (n=140), the safety and tolerability profile of LIPITOR 10 to 20 mg daily was generally similar to that of placebo (see CLINICAL PHARMACOLOGY, Clinical Studies section in full prescribing information and PRECAUTIONS, Pediatric Use).

OVERDOSAGE: There is no specific treatment for atorvastatin overdosage. In the event of an overdose, the patient should be treated symptomatically, and supportive measures instituted as required. Due to extensive drug binding to plasma proteins, hemodialysis is not expected to significantly enhance atorvastatin clearance.

Please see full prescribing information for additional information about LIPITOR.
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Global Events

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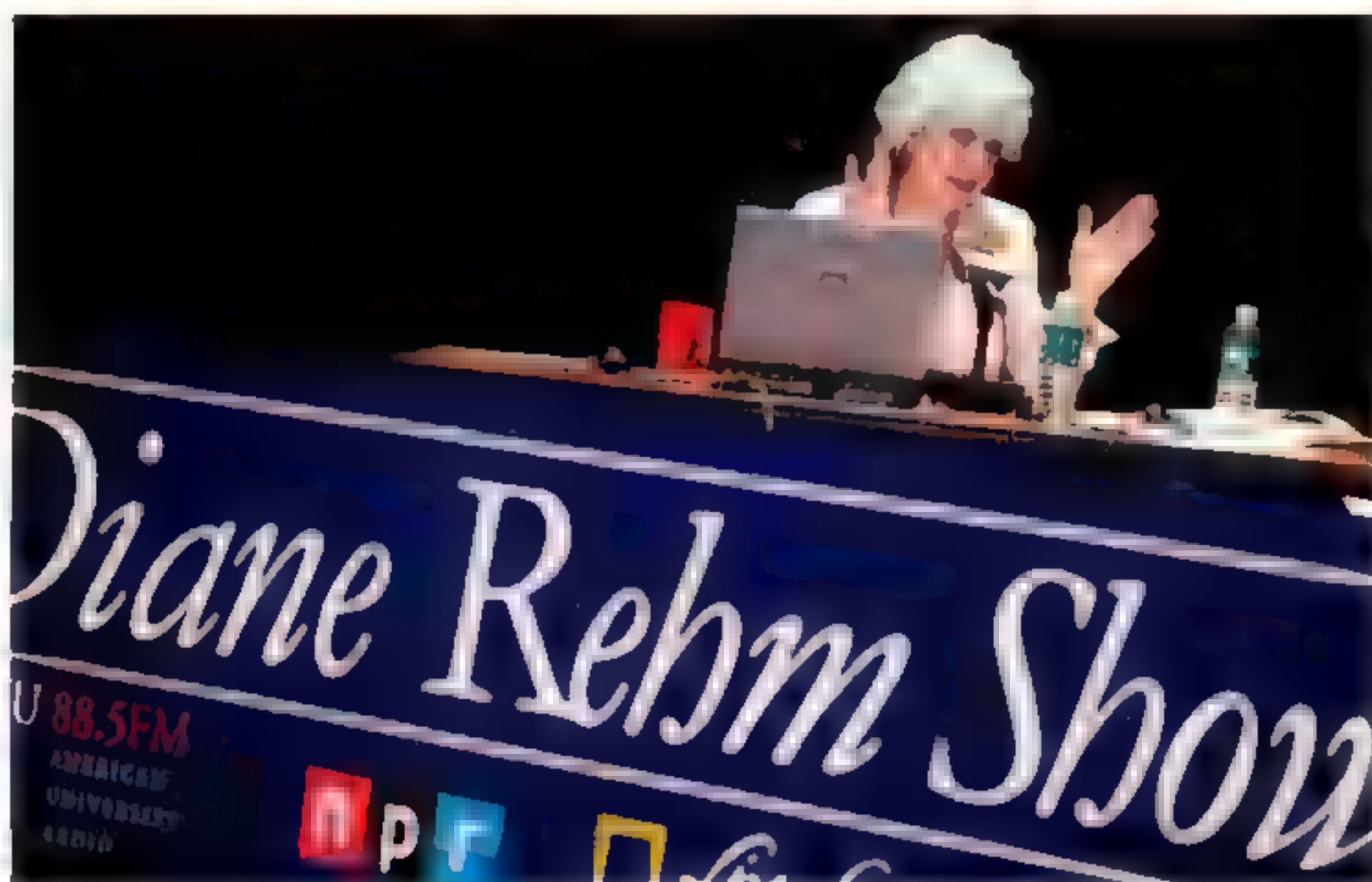
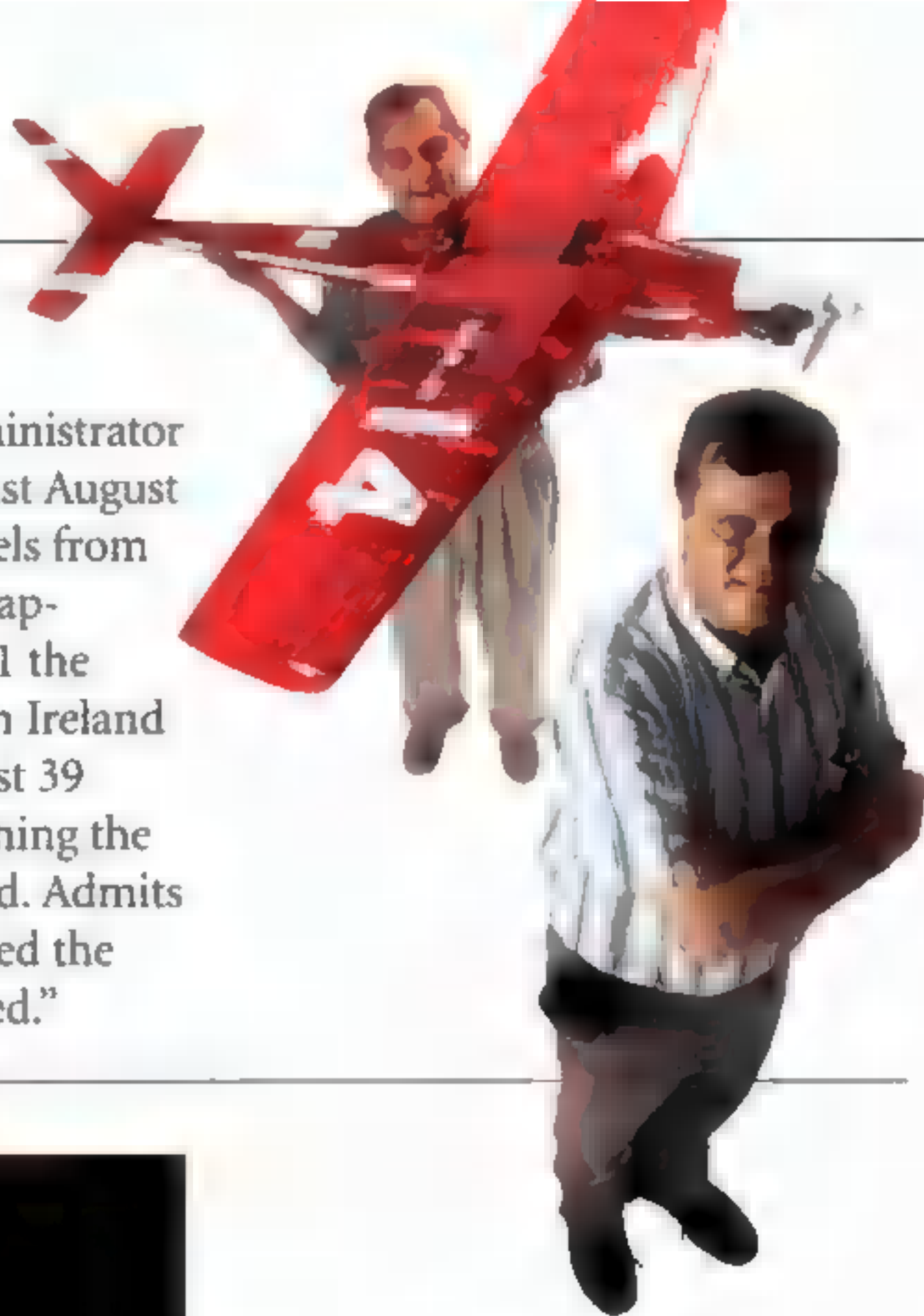
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S350 is only \$99.95 (plus \$15 shipping and handling) or three payments of \$39.25.

Model Plane Wings It Across the Atlantic

Retired engineer Maynard Hill (right top) wanted to create a gas-powered model airplane capable of crossing the Atlantic. He could design the model himself, but he needed help with navigation. So he called National

Geographic systems administrator Barrett Foster (right). Last August they launched two models from Newfoundland. One disappeared, but on August 11 the other landed on target in Ireland—1,888 miles and almost 39 hours after takeoff, crushing the previous 517-mile record. Admits Barrett, who programmed the flight path, “I was amazed.”



NATIONAL GEOGRAPHIC PHOTOGRAPHER MARK THIESSEN (BOTH)

Hello, Caller. I'm Listening.

Radio talk show broadcasts from Geographic's stage

Aclaimed talk show host Diane Rehm spends most Friday mornings with us, broadcasting her show, produced by WAMU and heard on National

Public Radio, live from our Washington, D.C., headquarters' auditorium. Part host, part traffic cop, Diane juggles guest experts, callers' questions, listeners' e-mails,

and her live audience. Noted journalists, among them Daniel Schorr and Susan Page, discuss the week's news during the first hour of the show. The second hour Diane explores subjects ranging from civil rights to romance novels. “Any topic works if you make it interesting,” says Diane, who swears one of her best shows was on pruning gardens. Reservations required, admission free. Call 202-857-7700.

Also at NGS in December

Tango Pablo Corral Vega presents photos (page 34). December 2 **A Celtic Christmas** Boys of the Lough perform. December 4 **Wings of Change** Joe McNally shows images from this month's cover story. December 10

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FLIGHT (PAGE 2)

- **The Wright Brothers and the Invention of the Aerial Age**, by Tom D. Crouch and Peter L. Jakab. The story of the bicycle-shop owners who started it all, by experts from the Smithsonian National Air and Space Museum. Includes dozens of archival photos. (\$35)
- **5 Nights of Flight** on the National Geographic Channel, December 15-19, 8 p.m. ET/9 p.m. PT. Celebrate the hundredth anniversary of the first flight with a week of programming: **Monday: Test Pilots** An inside-the-cockpit look at this death-defying profession. **Tuesday: Air Force One** A rare look at America's most famous plane. **Wednesday: High Flyers** Amateur aviators, from barnstormers to backyard rocketeers. **Thursday: The Rocket Ranch** A look at NASA technology, from the space shuttle to the Helios solar-electric aircraft project. **Friday: Charles Lindbergh: The Lone Eagle** How a 25-year-old pilot changed the world.

Who Knew?

PREHISTORIC MIGRATION

Lost Routes

The maps might lie inside us

Very high on the list of big unknowns in science (number one being, of course, Why is there something rather than nothing?) is the mystery of prehistoric human migration. How did human beings spread across the planet? Who went where, and when? Did anatomically modern humans evolve first in Africa? When did people colonize the Americas and the Pacific islands?

The fossil record is patchy at best. "It's just not fine grained enough to allow more than broad generalizations," says Ian Tattersall, an anthropologist at the American Museum of Natural History.

Paleontologists have to tease an elaborate tale from a fragmentary text of bones and teeth. But in the past decade clues to our early history have come from a completely new source: mitochondrial DNA.

Think of our genes as fossils. In addition to ordinary DNA, we have within our cells a separate ring of DNA inside tiny energy-producing engines called mitochondria. Unlike ordinary nuclear DNA that's sliced and diced and recombined during sexual reproduction, mitochondrial DNA (mtDNA) is passed whole from mother to child.

Mutations in mtDNA form recognizable patterns that scientists use to calculate how long different population groups (for example, Inuit and Australian Aborigines)

have been separated. The mtDNA record from living people can link modern humans through matrilineal lines to a common female ancestor who lived less than 200,000 years ago, probably in Africa. That conclusion jibes nicely with the fossil record.

"The fossil people are going directly back in time and looking at the actual record," points out Sarah Tishkoff, a geneticist who studies mtDNA at the University of Maryland. But the mtDNA approach requires an inferential leap. "We have to take the present data and infer about the past."

"There are so many ways to explain the same [mtDNA] pattern that it's often too easy to tell the story one likes and get away with it," says Lounès Chikhi, a French evolutionary biologist and critic of the mtDNA approach.

And mtDNA tells only the history of females. Men are invisible. Except in a few very rare cases, male mtDNA is lost in the shuffle because it doesn't enter the egg during conception. A fellow could cross half the planet, then sire a child, and his migration would go unnoted in the mtDNA record.

Individually the two strategies, fossils and genes, have drawbacks. But what if they were combined and we could extract mtDNA directly from ancient bones? The inferential leap into the past would no longer be necessary. Unfortunately ancient mtDNA—when a researcher is lucky enough to find it—is invariably degraded, though scientists report some progress on this front. As for the mystery of human migration, Tattersall notes: "There are a lot of ways of trying to solve it, but we haven't found the silver bullet."

Now if only those old bones could talk.

—Joel Achenbach

WASHINGTON POST STAFF WRITER

IT MATTERS

Mitochondria do much more than sprinkle genetic bread crumbs along the path of our ancestors' global wanderings.

Human bodies are built of trillions of cells and almost all of them contain mitochondria. These structures function like microscopic oil refineries, helping turn the "crude" food molecules produced by digestion into high-energy fuel (a compound called adenosine triphosphate) that the rest of the cell can use to do its work. Tissues that burn a lot of fuel—like heart muscles, the liver, optic nerves, and the brain—can have thousands of mitochondria operating in every single cell. And they don't just matter to people: From giraffes to geraniums, every multicellular organism on Earth runs on mitochondrial power.

—Lynne Warren

WEBSITE EXCLUSIVE

Learn more about mitochondrial DNA research—and find links to Joel Achenbach's work—at nationalgeographic.com/ngm/resources/0312.

Wings of

IN 1903 THE WRIGHT FLYER FLEW 40 YARDS. A CENTURY LATER THE BAT-WINGED B-2 BOMBER CRUISES HALFWAY AROUND THE WORLD BEFORE LANDING—PART OF A NEW GENERATION OF HYPER-COMPUTERIZED CRAFT BENDING THE RULES OF FLYING.

BY MICHAEL KLESIOUS PHOTOGRAPHS BY JOE McNALLY

NATIONAL GEOGRAPHIC WRITER



change



W

e take off into the radiance of a midwinter sun. Maj. Mark "Jocko" Johnson, a Marine Corps test pilot, shoves the throttles forward. Engines roaring, the U.S. Navy's newest and most advanced tactical aircraft, the F/A-18 Super Hornet, leaps down the runway with head-snapping acceleration. From the backseat, where I can just see over Jocko's helmet, I watch the expanse of Naval Air Station China Lake in the California desert rush past us. Our mounting speed feels like a truckload of sand pouring onto me. In less than half a mile the airplane springs aloft. Minutes later Jocko banks northward into the brown, bush-dotted fissures of the Sierra Nevada mountains, and we begin a terrain-hugging, gut-clutching ride at 540 knots—the speed of an airliner at cruise altitude. But we're only 500 feet above the folded landscape. He finesses the airplane through sharp turns and dodges mountain outcrops with the twirl of a wrist. When ridges appear in our path, he climbs, twists the aircraft onto its back, and curls above them, then holds us inverted for a brief count as we move into the next valley. I tilt my head back and peer out the top of the canopy at the rocky earth hurtling past.

Fifteen minutes and 133 miles later we exit the Sierra just south of Mount Whitney and streak across the





Shape and shadow combine the next generation of stealth technology, embodied in the U.S. Air Force's new F/A-22 Raptor. Set to begin operation in 2005, the Raptor is the world's first supersonic stealth fighter. Powerful onboard computers make constant corrections to keep its stealthy shape flying straight and steady at speeds up to twice that of sound. Such super-smart computers are ushering in a whole new age of manned—and even unmanned—flight.



The U.S. Navy's Blue Angels corkcrew above the Naval Air Facility El Coronado in California. The maneuver, known as a diamond roll, is among the most graceful for the Navy's top pilots. "I'm at the bottom of an imaginary pendulum," says Lt. Cmdr. Jerry Deren, flying the F-16 from which photographer Joe McNally captured the shot. Amid growing disorientation in the cockpit, the "Blues" are still flown by hand. "I had a tremendous sense of the plane's power," says McNally (left, in an F-16), "and a sense of sliding around in the air and constantly looking at the horizon."



U.S. NAVY

“The pilot’s job is to feed the dog; the dog’s

Owens Valley. “I’ll plug in the blowers,” he says, referring to the afterburners. “You’re gonna feel a kick.” Wham! Engines at full power, we ascend the 11,000-foot ridge of the Inyo Mountains. The horizon cartwheels, and we sail across like an arrow.

Moths awakening in my stomach, I decline his next suggestion, something called the squirrel cage. Instead, he takes us into a high-speed loop, topping out near 20,000 feet. As we plunge into the dive, with the frosted Sierra to our west and the toasted desert straight down, my queasiness suddenly vanishes. In its place, pure exuberance! I’m lost in the tumbling alchemy of earth and sky, my soul awash in the freedom, the audacity, the miracle of flight.

When powered flight turns a hundred on December 17, it’s worth noting what an adventure flying still is in a world where commercial air travel has become routine, uncomfortable, sometimes torturous. On our way back to base I thank Jocko for taking me up. “I should be thanking you,” he replies. “I was scheduled to fly a desk all day.” His passion for his calling salutes a century of aviators all the way back to the Wright brothers, while his airplane heralds the next century of aviation. The Super Hornet is now replacing the graying F-14 Tomcat on carriers throughout the fleet. As for the Air Force, they’re testing a new fighter, the F/A-22 Raptor, so revolutionary that it promises to redefine all notions of what’s next in the air. (The U.S. dominates the aerospace industry, especially militarily.) And both branches of the service, along with the Marine Corps, the British Royal Air Force and Royal Navy, and the air forces of several other countries, will soon fly a single-engine cousin to the F/A-22 called the F-35 Joint Strike Fighter. These planes all exhibit the stealthy angles and coatings that make it difficult for radar to detect them, among aviation’s most cutting-edge advances in design.

Many military technologies such as GPS navigation, lightweight composite materials, and the jet engine itself have led to applications in civilian aviation. But in contrast to the rapid progress in the military, the commercial airline

industry has fastened its seat belts for serious economic turbulence, as evidenced by a string of layoffs and bankruptcies. These woes are rooted in the faltering economy and fears of terrorism. War contributed to reduced ridership, while high oil prices forced airlines to pay more for jet fuel. SARS proved how fast international air travel can spread disease, further emptying seats.

Few landings have been harder or higher profile than that of the Concorde, which just retired from service. Grounded with it is the hope for mass supersonic travel anytime soon. Instead, the Europeans are trading speed for size as they build a new superjumbo jet, the 555-seat A380. Despite improved capacity, range, and fuel economy, the A380 will fly at roughly the same speed with the same basic design introduced by the Boeing 707 half a century ago.

But set aside the pessimism of the moment and take the long view: Since 1980, commercial aviation has grown at an average rate of 5 percent a year. Most observers expect it to return to historic growth levels from its current stagnation.

Then take the longer view: More than 200,000 humans are older than powered flight itself. Because the airplane is only a hundred years old, aeronautical engineers have big dreams for a long future. What will it take to make an affordable, faster, and safer Concorde? How much bigger can airplanes get? How many more can fit in the sky?

The answers to these questions, and others, are emerging with huge advances in computer automation. In the 1950s airplanes got fast; in the 1980s they got stealthy; today they’re getting smart. Brilliant, in fact. From the private four-seater to the massive A380, the airplane is evolving most dramatically on the inside.

In the military, computer automation has resulted in a new generation of airplanes called unmanned aerial vehicles, or UAVs, that fly without any pilots at all. Unlike civilian planes, military aircraft are evolving into radar-evading, unstable shapes that only computers can keep in level flight. Conventional forms, like the Predator and Global Hawk, are giving way to stealthier UAVs shaped like kites, bats, and boomerangs, all but invisible to enemy radar and able to loiter over hostile territory for a length

job is to bite the pilot if he touches anything.”

of time that far outlasts a pilot's fatigue limits.

“The computer can react much faster than the mind,” says Darryl Davis, a Boeing program manager for unmanned combat aircraft. “And if a UAV gets shot down, there's no prisoner of war on the six o'clock news.”

The absence of a sentient being aboard UAVs causes some to doubt whether they could fully replace manned aircraft. But few deny that UAVs are reinventing how wars are fought, generating a bird's-eye view of battlefields for commanders half a world away.

“It's interesting that the Wright brothers fought to get man into the air, and now we're fighting to get man out of the air,” says George Muellner, a former fighter pilot and now a Boeing senior vice president. “For tasks that are dull, dirty, or dangerous, we want to get the pilot out of the cockpit.”

Computers are now making private planes easier to fly and have spawned a new generation of entrepreneurs who want to reshape the airplane into a more convenient, affordable way to travel. “These guys are coming to aviation from technology backgrounds, not aviation backgrounds,” says Tom Poberezny, head of the Experimental Aircraft Association. “They're paradigm breakers. They're saying, ‘We can change the face of aviation.’”

In commercial aviation the growth of automation has resulted in computers that already fly the plane from just after takeoff to landing in almost any weather, turning pilots into flight-systems managers. UAVs now spark debate over whether cargo planes and even airliners of the future could fly pilotless.

“Airplanes are now built to carry a pilot and a dog in the cockpit,” says Arlen Rens, a Lockheed Martin test pilot. “The pilot's job is to feed the dog, and the dog's job is to bite the pilot if he touches anything.”

Once again I'm hurtling down the runway, this time in a Delta Airlines 757 at the Cincinnati airport. My wife, Giuliana, sleeps peacefully next to me by the window. On my right another woman dozes. Amid the din of the engines, with the plane's nose rising, several other people are—sleeping! How do they do it? At such a mystical

moment, with the thrill of the takeoff at hand and the shackles of Earth falling away?

I think back to my first airplane ride, a treat from my grandparents when I was 12 years old. For months beforehand the anticipation was unbearable. Finally the day arrived with overcast skies and a March chill. We flew a 727 out of Washington National Airport on a 45-minute flight to Cleveland to see relatives. My granddad and I sported coat and tie, my grandmother proud in a new dress. They ordered a ceremonial drink. I was treated to a soda and the window seat, where I sat bolt upright looking out the entire way. I'll never forget that first climb, up into leaden blankets of cloud and then, suddenly, brilliant, blinding flashes of white and blue as we rose from a sea of whipped egg whites into what surely was heaven.

Today I'm in jeans. The woman on my right wakes. She's on her way to Los Angeles for business and assures me that the first time she ever flew, at age 18, she didn't sleep on takeoff. Now flying is routine.

“We live near the airport,” she says, “so even for my two-year-old, airplanes are just a natural, everyday thing.”

My neighbor is one of about 300,000 people who are airborne at the same time over the continental U.S. each afternoon. That figure will rise in coming years. Projections of population growth suggest that the country will need about 25 more large airports by 2028. How is the FAA handling this challenge? For the present, air travel has been improved by a high-tech facility that came on line in the 1990s, the Air Traffic Control System Command Center.

From an unassuming office building in a field not far from Washington Dulles International Airport, the center manages the flow of airplanes over the country each day. One computer shows about 6,200 commercial flights in the air. Before 9/11 there could have been as many as 8,000 at the busiest part of the day, especially around Thanksgiving. Represented by little arrows on the computer screen, the flights look like green ants swarming over a hill. Every two hours employees here conduct a conference call with dozens of controllers and airline officials around the country, identifying trouble spots that could jam the system. On 9/11, for the first time ever, the center



sent out the command to ground all airplanes over the U.S. Often it helps reroute planes, or holds them on the ground, in bad weather.

The center represents an air traffic control system that has endured for half a century—and one that will soon change dramatically. “The future of air traffic control is about removing constraints,” says Jack Kies, the center’s director. Kies, an air-traffic-control veteran of three decades, embodies the essence of his profession: relaxed yet fast talking. How to remove constraints, such as the crowding of planes at a given altitude during thunderstorms? “Free flight is the concept we’re looking at,” says Kies, referring to a system in which air traffic control will be supplemented by computers on each plane that calculate altitude and route, increase awareness of weather and other planes, and allow airlines to work directly with their pilots. The idea is analogous to how packets of data flow across the Internet, rather than to a traffic cop waving cars through an intersection. The pilot will become important in a new way: programming a safer and more efficient path of his or her choosing into the computer.

“I think ten years from now we won’t be using radar anymore,” says Kies. “It’s too slow. And we should be asking, will we need this

air traffic control system? I suggest no. I see it replaced by a more integrated process between airlines, pilots, and ground control.”

Radar will be almost useless for tracking the Lockheed Martin F/A-22 Raptor, considered by many the most advanced aircraft ever built. Sitting in a mock-up of the Raptor’s cockpit in a darkened room on the outskirts of Atlanta, Georgia, at the plant where the company assembles the craft, I face several flat-panel, liquid crystal displays.

“I’m going to show you the airplane,” says Dick Mather, at the time an executive with Lockheed Martin. “You’re going to fly it. And then I’ll show you the future.” Moments later a projection of the Nevada desert races beneath me at Mach 1.58, or 1.58 times the speed of sound. The horizon responds to my slightest inputs on the side-mounted control stick.

When he was in the Air Force, Mather flew the F-15 Eagle, the aging fighter the F/A-22 will replace starting in 2005. Now he moves around the room like a cat, throwing switches and adjusting my view and talking with his hands.

“I think of this airplane as a stealthy, supersonic duck,” he says, describing how the F/A-22 might approach a surface-to-air missile site the



IMAGE PROVIDED BY AIRBUS

way a duck approaches a hunting blind. “If you’re an average hunter against an average duck, you’ll see and hear the duck early. You’ll bring your sights up to bear on him, you’ll lead him a little bit, you’ll shoot. If you don’t hit him, you’ll lead him a little more and shoot again. You’ll eventually get him.” But the F/A-22 doesn’t appear on radar until it’s almost too late to shoot. “You might get your sights up and maybe even get a shot. Or maybe not, because that duck is, zoom! Right through your field of view.”

How large the Raptor appears on radar is classified and depends on the quality of the radar. But Paul Metz, the first test pilot to fly the aircraft, remembers an exercise in which an F-15 pilot was told that Metz was approaching head-on. The F-15’s radar couldn’t find the Raptor.

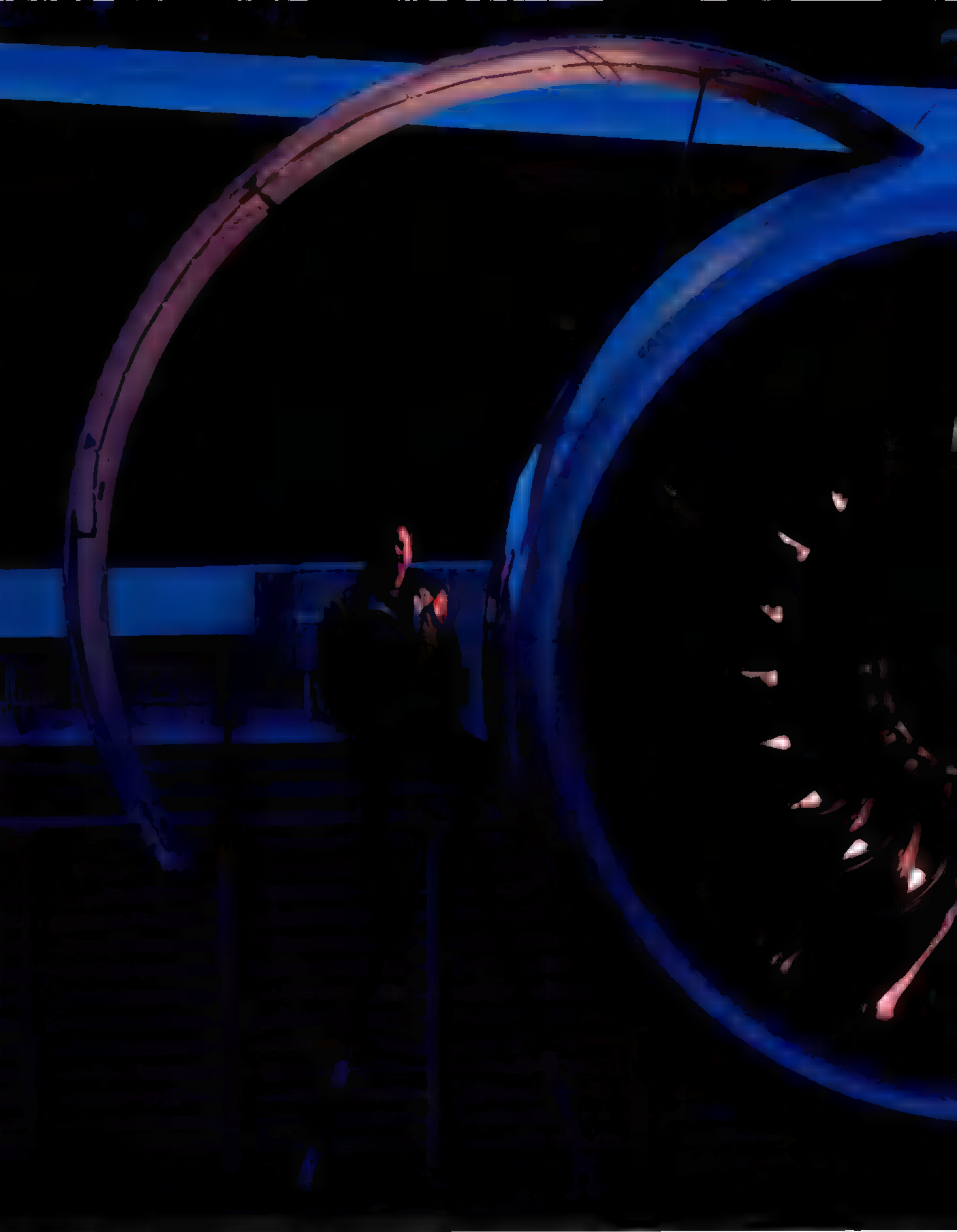
“The first time he got a read on me was visually, when I flew right over the top of him,” says Metz. “For me, thinking about the stealth capabilities of the airplane, that’s when the lightbulb really came on.”

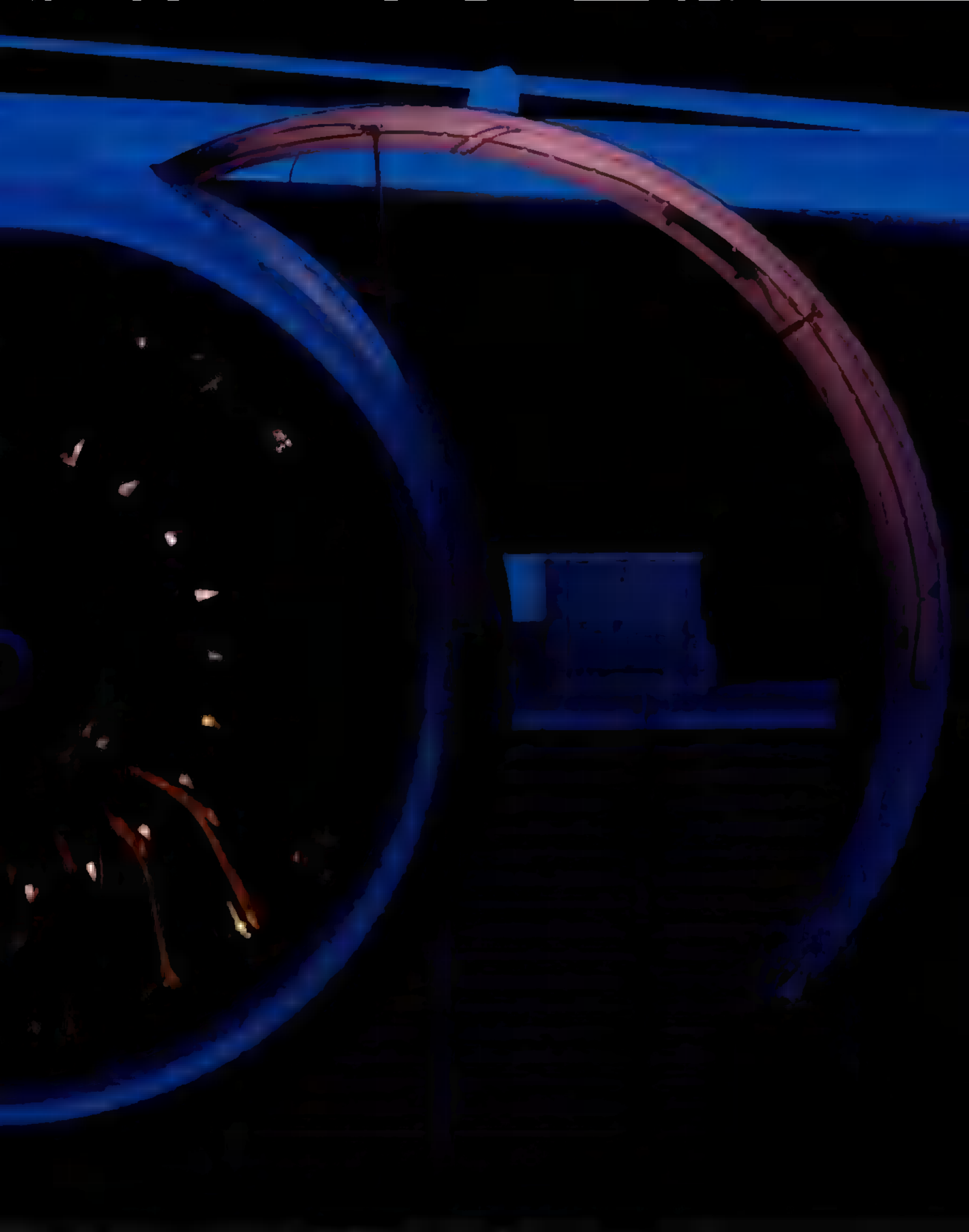
The F/A-22 represents a transformational technology, redefining how tomorrow’s fighter will fly and giving pilots what they call air dominance. It can cruise at supersonic speeds for long periods without using gas-guzzling afterburners, whereas conventional fighters quickly run out of fuel. This

Mothballed by a stagnant economy and the aftershocks of 9/11, more than 2,000 airliners sit in storage yards like one in Mojave, California (left). In their wake, Europe’s Airbus A380 (computer-generated image above), the first fully double-decked passenger jet, will take flight in 2008. It promises a 15 to 20 percent improvement in operating costs and 555 seats in three classes—139 more than the typical jumbo jet currently flying.

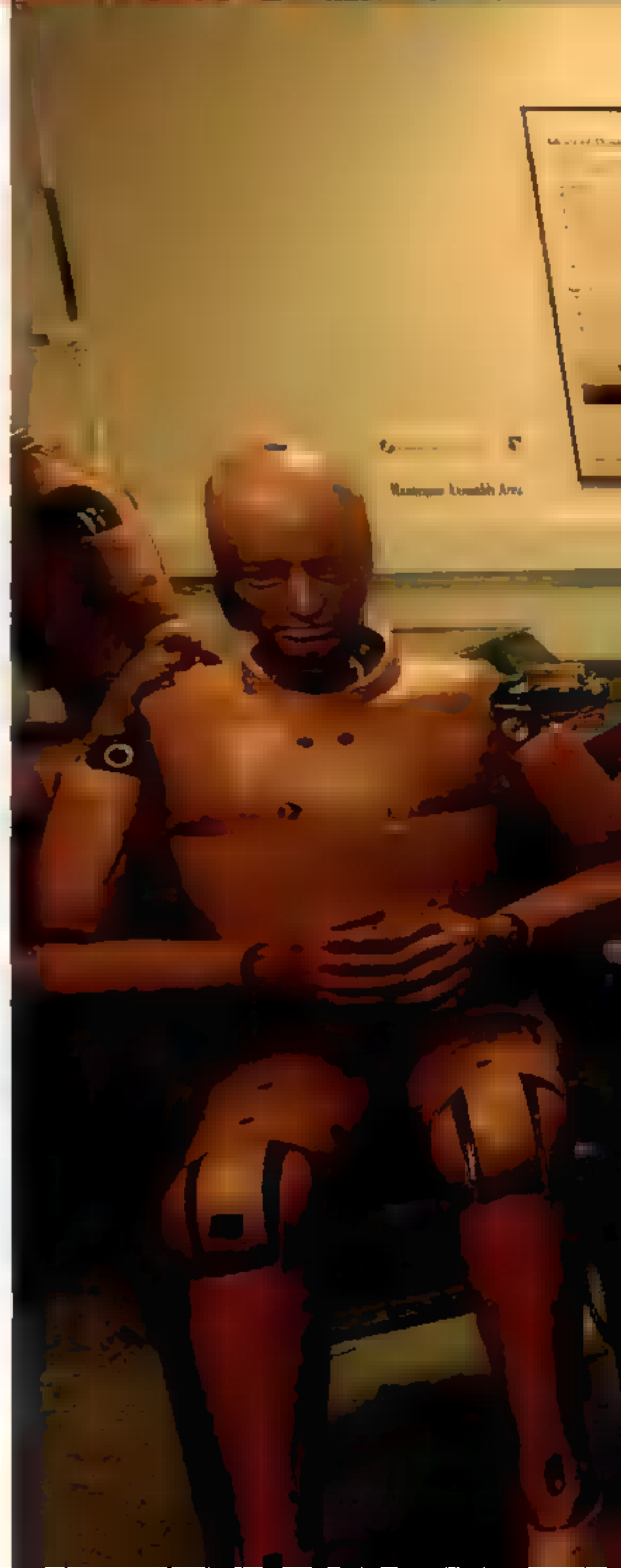
“supercruise” ability results from low aerodynamic drag because the F/A-22 carries its missiles and fuel internally instead of beneath the wings. Furthermore, its engines produce more than 40 percent greater thrust than those of the F-15—and more noise. It was thunder on the sunny day when I stood in the grass near the runway at the Lockheed Martin plant and watched a Raptor take off, headed for Edwards Air Force Base in California to join the flock of test aircraft there. The fighter howled past us while its escort plane, an F-16, had to fire its afterburner to keep up.

The Raptor runs on unprecedented levels of computer power. Whereas the Saturn V rocket, first flown in 1967, contained about 16,000 lines of computer code, the Raptor carries two million. Its designers have tucked the processors into two computer *(Continued on page 20)*





How do you take a 235-ton Boeing 777 from zero to 80 in six seconds? With the world's most powerful jet engine, the new General Electric GE90-115B, dwarfing Boeing technician Jeff Adamson. Quantum leaps beyond the first jet engines of the late 1930s, the GE90 churns out 150 times their thrust and could suck all the air out of Madison Square Garden in two minutes. With a fan built of weight-saving composites, the GE90 will soon power extended-range 777s on flights up to 18 hours.



Taking Humans to the Limit

Overcoming the bounds of the human body presents an ongoing challenge for the designers of tomorrow's aircraft. At Wright-Patterson Air Force Base a mannequin (right) called LOIS (lightest occupant in service), weighing a slight 103 pounds, endures a 10-g impact wearing night-vision goggles. "They keep adding more onto the helmet these days," says designer Glenn Thomas (below). "The strength of the human neck becomes a critical factor, especially for LOIS." The 245-pound model, nicknamed LARD (large anthropomorphic research dummy, below at right), tips the top of the scale. More traffic in the skies demands that pilots maintain a high level of awareness about their environment. Surrounded by a mesh of 277 speakers, Air Force Capt. Louis Duncan (lower left) listens to 3-D cues that could one day save him from a crash. In a 737 cockpit simulator, a head-up display projects speed, direction, and altitude into the field of view for Boeing test pilot Mike Carriker (left).



“Hypersonic flight gets you anywhere on

bays near the nose, leaving a third bay empty in expectation of computing ability not yet fathomed. The computers allow the sophisticated electronics, or avionics, to talk to each other in an integrated way never before possible, minimizing the tasks of flying, and allowing the pilot to focus on the mission.

Finally, the engines' exhaust nozzles can direct thrust up or down, which allows the pilot to jackknife the Raptor through turns tight enough to shake pursuers or lock on to quarry.

“Orville and Wilbur gave us the basics,” says Mather, “and we’ve been improving ever since. We’ve had stealth, speed, avionics, and agility. But we’ve never put them all into one airplane. If you understand those four pillars, then you understand the Raptor.”

With increased agility comes the problem of

the force of gravity, or g-force, the stress applied to a pilot's body when the airplane maneuvers at high speed. G-force causes blood to drain down from the brain temporarily, extinguishing vision or even consciousness. Several weeks after my virtual flight in the F/A-22, Maj. Beau “Ripple” Booth gives me a lesson in g-force during a real flight in the Air Force's F-16 Fighting Falcon when he yanks us into a turn at 500 knots. My gravity suit's air bladders inflate against my legs to counteract the blood pushing downward. I also begin the prescribed straining maneuver—holding a deep breath and flexing every muscle in my body. But he takes us to the brink of 9 g's, which crushes me in my seat as if I weighed three-quarters of a ton. I can't take it. Vision fades to darkness, and I begin to pass out. He eases off. I come back disoriented and nauseated, my sight returning as chaotic pinwheels and checkerboards.



IMAGE PROVIDED BY SCALED COMPOSITES

A spaceship for the rest of us—that's the new goal of Burt Rutan, the aviation visionary who designed *Voyager*, the first aircraft to fly around the world without refueling in 1986. “By 1908 maybe ten people had flown in an airplane,” says Rutan. “By 1912 thousands were flying. Space hasn't seen that spurt yet.” In an effort to trigger such a boom, the X PRIZE Foundation of St. Louis, Missouri, has offered ten million dollars to the first team to finance, build, and launch a vehicle able to carry three people a hundred kilometers (62.1 miles) high and land them safely. The catch: Perform a second launch of the same ship within two weeks. Rutan says his entry, *SpaceShipOne* (above, foreground) will drop from the mother ship, in background, at 50,000 feet, fire its engine, and fly a parabola that crests at the jackpot altitude. The rocket motor, at left, runs on solid fuel and nitrous oxide—popular with drag racers—while the van at right serves as mission control. “We look to the future,” says Rutan. “Hopefully, within ten years ordinary people can experience a rocket flight above the atmosphere, enjoy a few minutes of weightless excitement, then feel the thunderous deceleration of aerodynamic drag on reentry.”

the planet in less than four hours.”

“Welcome to the 9-g club,” says Ripple, his voice still distant in my ears. “Did you almost take a nap?”

On my way toward blacking out, I noticed that Ripple spoke comfortably during the turn. That’s because he’s a seasoned fighter pilot who knows how to perform a good strain. He’s also testing an innovative gravity suit used by the German air force that lets the pilot relax his upper body during the straining maneuver. Made by the German-Swiss company Autoflug Libelle, the suit replaces air bladders with sealed vessels of fluid. During hard turns this fluid bulges downward and increases tension in the suit’s fabric, more effectively stanching blood flow to the lower extremities.

“In the old gravity suit, pilots strain against their glottis,” says Peter Stumpen, an aeronautical engineer with Autoflug Libelle. “That shuts off breathing. In the new strain the pilot flexes the muscles in his lower body, but with less force. So the suit reduces fatigue.” Equally important, pilots can continue talking to each other.

Libelle is the German word for dragonfly, the insect with a cushioning liquid surrounding its organs that allows it to maneuver tight turns at high speeds. Stumpen says the suit’s designers don’t think of it as employing fluid bladders. “We call them fluid muscles,” he says, stressing their independence from hoses and pressurized air on board and their immediate response to high g’s. The liquid doubles as a survival tool, because the pilot can drink it after an ejection.

“We know the fluid is water-based, but they won’t reveal exactly what it is,” says Ripple. “We know it’s from Germany, and we know you can drink it. I’m thinkin’ it’s beer.”

Potable gravity suits and other advanced concepts begin with possibilities and end with practicalities. People like NASA’s John Zuk are trying to make busy airports more practical by stretching notions of what is possible.

“What problem are we trying to solve?” asks Zuk. “The gridlock problem, of course. The new push is to utilize underused airports and airport space.” Zuk claims that the safest place in the air is right over the airport because it’s underutilized. Counterintuitive but true, this stems from

the fact that incoming and outgoing traffic flies relatively close to the ground for miles off each end of the runway, forming a wide V through which other aircraft can cross higher up. And so small aircraft of the future might fly into that empty airspace at a steep angle, executing precisely curved approaches to land on taxiways, guided by GPS and electronic controls, and commanded by computers. “It would be analogous to the express lane at the supermarket,” Zuk says.

The future may also offer alternatives to the concept of humans as FedEx packages, batched and sent through large “hub” airports, then reloaded onto secondary flights to “spoke” airports near destinations. This hub-and-spoke model barely existed before the U.S. deregulation of airlines in the late 1970s. After deregulation, competition between airlines brought about extensive hub-and-spoke, helping to reduce average fares by about a third over the next two decades. During that time overall plane traffic nearly doubled. At the Cincinnati airport, the hub through which Delta funneled my wife and me, traffic jumped about three times. But meanwhile, the system began to reveal inefficiencies, with all planes showing up at once, then departing at once, subjecting airport employees to periods of frenzied work followed by idleness. Worse, individual delays caused a domino effect through the entire system. Slowly delays mounted, reaching a daily average of 1,670 by June 2000. That summer was a glimpse of future gridlock.

To prepare for that future, Airbus Industrie, a European airplane maker, is supersizing commercial transportation. At the beginning of 2005, the A380, the world’s first fully double-decked superjumbo passenger jet, is expected to take off from Toulouse, France, on its initial test flight. If all goes well, the 1.2-million-pound airplane will begin service in 2006, with room for 555 passengers in a mix of first, business, and economy classes. A model envisioned for the future and filled only with economy seats may carry 840 passengers. Airlines have ordered more than a hundred A380s, the first of which hasn’t even been built. The plane speaks volumes about the entrenched hub-and-spoke concept, at least for international travel.

“Last month I flew from Toulouse to Phoenix



The Floating Airfield

Despite advances in aviation technology, people on the ground, or on the deck, still keep planes in the air. On New Year's Day 2003, the aircraft carrier U.S.S. *Abraham Lincoln* was heading home, ending a six-month tour, when it received orders to turn around. A few months later, during the war in Iraq, crews worked 16-hour days launching the carrier's aerial armada of F/A-18 Hornets (left and below) and F-14 Tomcats, and found respite where they could, including the exhaust cone of an F-14 (right). After ten months and more than 100,000 miles the *Lincoln* arrived at its home port of Everett, Washington, with a new record: more than 12,700 safe landings, including one bringing U.S. President George W. Bush aboard.

Personal diversions ease the strain of such tours. "I'm basically a karaoke addict," says Aviation Electronics Technician 2nd Class Dean Gibson (bottom left), who croons in the mess hall Wednesdays and Saturdays. Others head to Cecilia Fresques's workouts (center left). "Exercise helps keep up morale on the ship, and that's a huge thing," she says. "And the cardio-kickboxing lets them throw a punch."





for business,” says Philippe Jarry, an Airbus senior vice president and one of many at the company who feel that the hub-and-spoke system is here to stay. “I went from Toulouse to Paris, changed planes; Paris to Dallas, changed planes; and Dallas to Phoenix. Of course I would have preferred a nonstop flight from Toulouse to Phoenix, but I was probably the only person on the planet that day flying Toulouse to Phoenix. It doesn’t make economic sense to have a flight just for me.”

Airbus projects that passenger air traffic will triple by 2025, a prediction shared by NASA. Jarry also points to UN projections indicating that by 2015 some 20 cities will have 10 million or more people, and 6 cities will have more than 20 million.

“These are where you’ll combine wealth and the need for air travel,” he says. But the A380, he adds, is about more than size. “We didn’t start out to make the world’s largest commercial aircraft. The airlines wanted a 15 to 20 percent improvement in efficiency, and that caused the plane to grow.”

Amid the reality of hubs and spokes, Bruce Holmes, associate director of airspace systems at NASA’s Langley Research Center, has found that more than 98 percent of the U.S. population lives

30 minutes or less from one of about 5,400 small, local airports, those used mainly by small private and business planes. Only about 10 percent of these airfields have precision instrument guidance, communications, and radar coverage for safe operations in bad weather. But they represent an untapped capacity that could relieve pressure from hub-and-spoke airports. Holmes has devised a concept called the Small Aircraft Transportation System (SATS), which would make better use of these airfields by equipping airplanes with GPS, digital radios, and advanced software to create a broadband, wireless Internet in the sky. The system would keep pilots informed about weather, traffic, and other hazards, even in thick fog, and provide them a virtual image of the terrain over which they’re flying. As the costs of computing power plummet, tomorrow’s pilots of small planes will be able to access huge quantities of information, just as today’s airline pilots do.

“It’s free flight for small planes,” says Holmes. His research shows that the high speed of airliner travel is defeated by time spent getting to and from airports and by “the congestion of the airport infrastructure, the gridlock in the air. The system is hidebound.” Instead, he sees a future where passengers can take point-to-point,



on-demand service between small airports.

Holmes's vision dovetails with that of Vern Raburn, whose company, Eclipse Aviation, is producing a business jet for around a million dollars, about a quarter the cost of the lowest priced business jets in the air.

"We're the poster airplane for SATS," says Raburn. The industry, he says, has become an exercise where airlines cram people onto flights that hold 100 to 200 passengers. "You go when they want you to, and where they want. Then you drive a long way from your final airport to your destination."

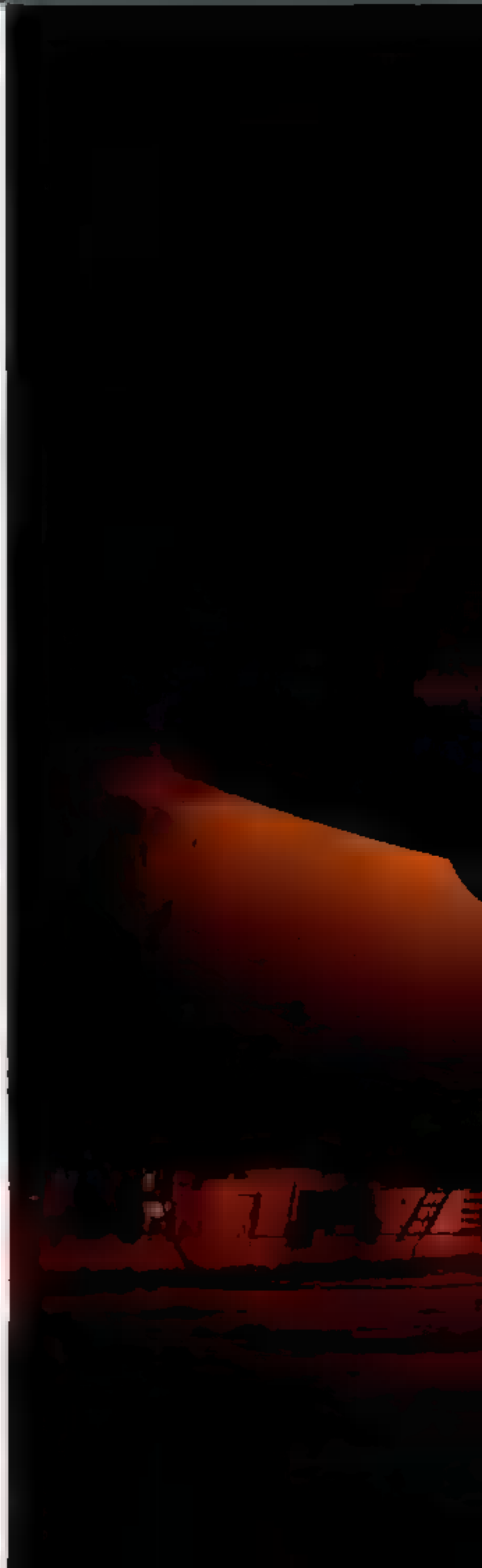
His new jet, called the Eclipse 500, is still being tested. But he says that he's received more than 2,000 orders from buyers, including two who plan fleets of on-demand, point-to-point jets creating an "air taxi" service.

"We're challenging the status quo of this industry. All the experts running bankrupt airlines say it can't be done. Their only concept is big airplanes with lots of people. These airlines are dying like dinosaurs, Jurassic age business models. They screw a bunch of vendors, customers, and taxpayers, and then they come out of bankruptcy and they're still the same thing."

Point-to-point service could also get a lift from the idea that planes may not need runways.

Model planes with a mission, unmanned aerial vehicles, or UAVs, are the next generation in the military arsenal. The backpackable Dragon Eye (above), rigged for day and night surveillance, helps marines see over the next hill, while jet-powered X-45s (left) may one day deliver bombs. "What's amazing is that one person can now control several UAVs," says Darryl Davis, the Boeing manager for the X-45. Will it fully replace piloted aircraft? "Not yet. That might be for the third century of flight."

Tilt-rotors, airplanes with rotors that provide vertical lift and then pivot forward for horizontal flight, are already in the air. The military version, the V-22 Osprey, was grounded after two accidents in 2000 that killed 23 marines, but the Marines, Navy, and Air Force have resumed flight testing. After new designs of troubled hydraulic and electrical lines and new guidelines for its safe descent, top skeptics at the Pentagon voiced renewed confidence in the Osprey. This military technology is spreading to the civilian sector with the BA609, a smaller, lighter tilt-rotor being tested by Bell/Agusta that promises to bring more people into city centers or other destinations instead of airports. So far, helicopter operators, oil companies, and sports figures have ordered 70 of the craft.



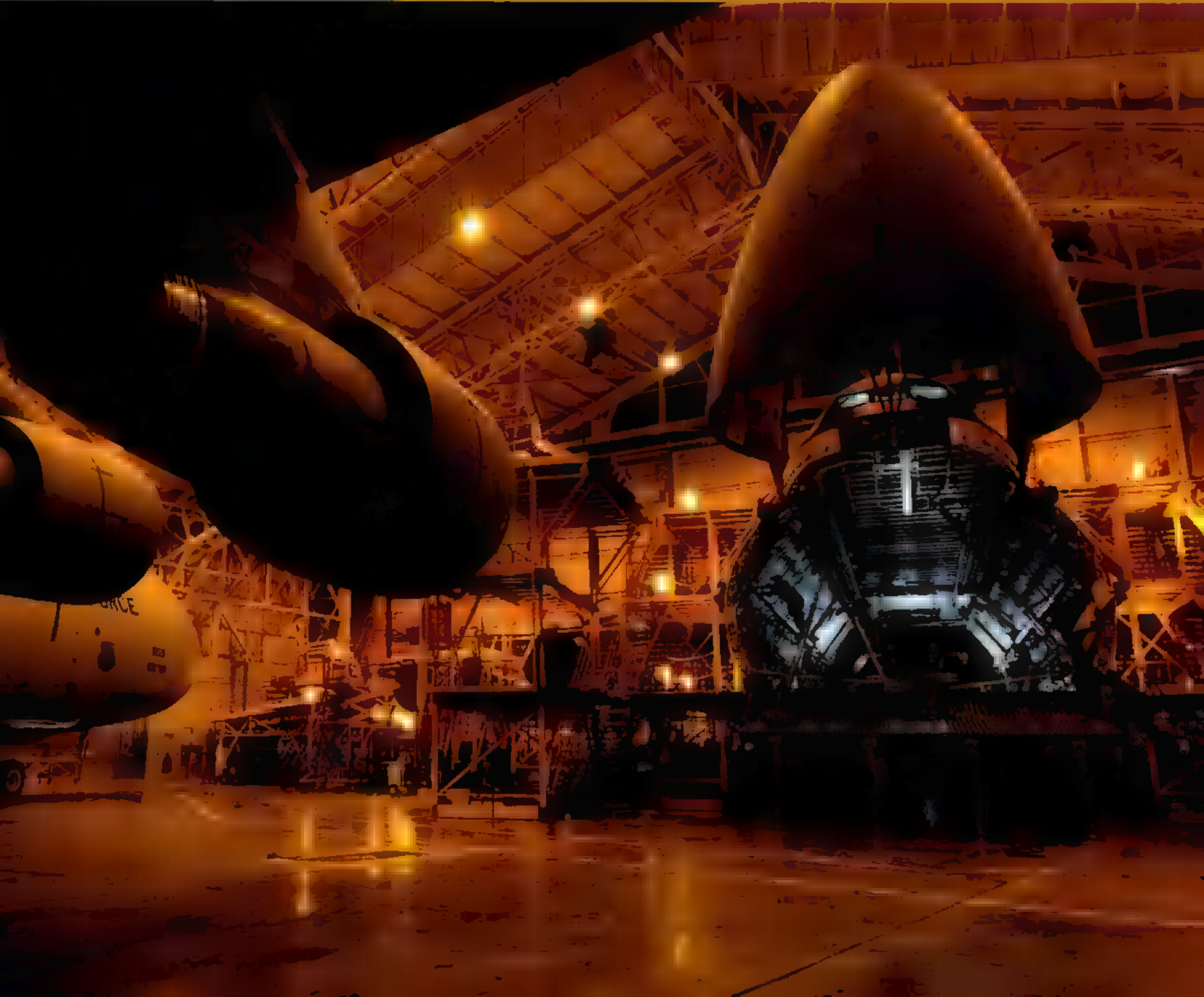


A New Lease on Life

From the 1960s on, the SR-71 Blackbird was the hottest thing in the air—literally. “When we landed, the maintenance guys were real careful not to touch the airplane,” says Ken Collins, retired Air Force colonel (left), on the nose of the top-secret spy plane that he flew faster than Mach 3. Air friction pushed the temperature of the canopy to around 600°F. “From the heat expansion, the air-frame grew by several inches in flight,” Collins recalls. The plane he loved to fly nearly killed him in 1963 when a systems failure forced him to bail out over Utah. “I was back in another Blackbird in a week,” he says.

Though the Air Force no longer flies Blackbirds, other aircraft of their era are being reborn, like the 1970s-vintage C-5 Galaxy cargo plane (below), being inspected at Stewart Air National Guard Base in New York. Face-lifts include cockpits rewired with new digital avionics. Propellers made from innovative composite materials power the new model J of the venerable C-130 Hercules (bottom left), a large, propeller-driven cargo plane in production since 1954.

“We can rebuild them. We have the technology,” says Lockheed Martin’s John Walther.





Light-years from the Wright brothers' bicycle shop in Dayton, Ohio, workers at a Lockheed Martin facility in Georgia put the finishing touches on an F/A-22 Raptor, which has more than a million parts. Around a thousand technicians turn out one a month.

In a variation on the tilt-rotor concept, some designers envision the entire wing of a military transport tilting back, pointing its propellers up at a 20-degree angle on takeoff and landing. This "tilt-wing" aircraft would use the airflow from the propellers over the wing to take flight in half the distance and with half the speed that Jocko needed in the Super Hornet, and without a paved runway. The tilt-wing would have no vertical tail, saving weight and reducing drag. Computers would keep the airplane straight and level by constantly working the split ailerons, the wings' movable airfoils that add or reduce drag. This technology is already used by the tailless B-2 stealth bomber.

For moving massive loads, there's the Pelican. A futuristic cargo plane, the Pelican could fly as low as 20 feet above water, where its proximity to the Earth's surface would decrease drag and increase the efficiency of the wing. Known as ground effect, this phenomenon of aerodynamics could offer major fuel savings for a large-scale cargo transport flying over water.

"Birds, and pelicans in particular, exploit ground effect in the most fantastic way," says Blaine Rawdon, the Pelican program manager who has been studying the idea. "I live near the ocean, and I watch pelicans as they glide across the waves. Their wing tips nearly touch the water sometimes."

Still highly conceptual, Rawdon's Pelican might be 400 feet long, with a 500-foot wingspan and downturned wingtips. Fully loaded, it would carry ten times the payload of a jumbo jet. All this mass would cross the ocean at 240 knots, or roughly half the speed of an airliner, relying on radar to avoid ships and icebergs. "This is in essence," says Rawdon, "a flying ship."

If it sounds too futuristic, it's what guys like Rawdon are hired to do. "From our perspective," he says, "anything that's already flying is history."

Sometimes history is made by accident. In the fall of 2002, private pilot Lionel Morrison found himself in a terrifying situation, his Cirrus SR22 single-engine propeller airplane rolling and diving to the left over suburban Dallas. His

left aileron was hanging from the wing—the apparent result of a mechanic's oversight—a problem serious enough to rule out landing the plane. Morrison flew onward, pulling sideways on the stick to keep the plane level, and eventually reached unpopulated terrain. Here he decreased his speed to 120 knots and, 1,800 feet above the ground, shut off the engine. Then he wrenched a handle downward from the ceiling.

"There was a pause," he remembers. "About a second. And it was a long second. I'm saying, Okay, is it gonna fire? Then I heard it, and it's a wonderful sound, I guarantee you."

The sound was of a mini-rocket shooting outward from the top of the airplane and deploying a parachute that can save the plane and its pilot. Huge straps embedded in the body of the Cirrus unfurled as designed.

Morrison and his plane parachuted down and landed in a grove of mesquite and cedar trees near a golf course, his only injury a mild neck sprain from impact. At that moment flying light planes got a lot more attractive.

"Right afterward," says Morrison, "I had conflicting thoughts about my future in aviation. Sort of an emotional response. I'd dodged a bullet, and I said to myself, you should count your blessings and call it a day. But later I thought, you've experienced something that no one else has. And now I know I won't panic. I'm still comfortable flying my plane, but I'm no longer as comfortable in other small airplanes without parachutes."

As Morrison climbed from the cockpit, a golfer appeared.

"He was amazed, looking at this thing," says Morrison. "It was like I was from Mars." The golfer asked, "Are you sure you're OK?" Morrison replied in the affirmative. "So he said, 'All right, then, if it's OK with you, I'm gonna go back to my game.' I said, 'That's fine.' I understood. I'm a golfer too."

While Cirrus's lifesaving chute brings the airplane softly back to Earth, a different technology may propel it to new heights and velocities that will make the Concorde's Mach 2 speed seem hop-along. In the summer of 2002 Allan Paull and a team of scientists from the University of Queensland shot a rocket into the sky over the Australian outback. The rocket carried a scramjet engine experiment. Unlike a conventional jet engine that pressurizes air between wheels of compressor blades, a scramjet relies





Part helicopter, part airplane, the V-22 Osprey flies again at the Patuxent River Naval Air Station in Maryland, where it's being tested after a redesign. Two fatal crashes in 2000 grounded the Osprey and were a sober reminder that aerial innovation is not without risk. Known as a tilt-rotor, the V-22 takes off vertically, then tilts its engines forward for winged flight. Advocates claim it provides twice the speed, three times the payload, and five times the range of the helicopters it's meant to replace.

on the supersonic speed of the aircraft and the design of the intake. Paull's team used the rocket to take their vehicle to more than Mach 7 and then operated the scramjet for about five seconds. It was the first time anyone had achieved fully supersonic combustion in flight, and it showed that the technology works for moving at rocket speeds with a more efficient air-breathing engine. Their project was called HyShot, and their fuel was hydrogen.

Mark Lewis of the University of Maryland's aerospace engineering department explains that while rocket engines like those of the space shuttle have achieved hypersonic flight for decades, they are forced to carry not only hydrogen but also the critical second ingredient, liquid oxygen, in an enormous external fuel tank. A scramjet, on the other hand, is lighter and more efficient, because it uses oxygen from the atmosphere. "Flying an air-breathing rocket system above Mach 5," says Lewis, "that's sort of the gleam in everyone's eye."

Future hypersonics could bring this efficiency to such military applications as sending a high-speed air-breathing cruise missile to intercept terrorists on the move. Over the next several years NASA scientists, along with the Air Force, will conduct their own tests of both hydrogen and hydrocarbon fueled scramjets under the X-43 program. The X-43s are unmanned vehicles that look like high-tech surfboards and will explore velocities up to Mach 10. Big challenges remain. For example, there is as yet no lightweight material that can endure the prolonged 3000°F-plus heat of air friction against the wings, fuselage, and engine at such speeds. The space shuttle *Columbia* disaster last winter reminds us of the risks of hypersonic flight.

Yet, while the distant future of flight is impossible to predict, it's also impossible to underestimate. Richard Hallion, an aviation historian, illustrates the promise of hypersonic research for eventual commercial travel. He draws a time line, beginning with a vertical line for 1800. "Back

then animal-drawn carts moved about six miles an hour," he says. He draws a vertical line to the right. "In 1900 we had the steam locomotive, about 60 miles an hour." He

Defying gravity with a vengeance, test pilot Maj. Jim "Mash" Dutton streaks over California's Sierra Nevada in an F/A-22, living the words of Charles Lindbergh: "Science, freedom, beauty . . . what more could you ask of life? Aviation combined all the elements I loved. Adventure lay in each puff of wind."

makes a line farther to the right. "In 2000 we're going about 600 miles an hour in commercial jets." He draws a fourth line. "In 2100 . . ." and he draws a question mark. "Suppose Orville and Wilbur had gone to Teddy Roosevelt and advocated the complex system of air travel we know today?" he asks, planting a finger on the year 2000. "He'd have thrown them out of his office as hopeless dreamers."

"Essentially, hypersonic flight gets you anywhere on the planet in less than four hours," says Larry Huebner, a NASA hypersonics engineer working on the X-43. While he asserts that it will start with military applications in the near term, Huebner also doesn't rule out the possibility of hypersonic commercial travel someday. "It may also eventually provide a form of leisure space access for tourists," he says. "Think about it: The Wrights only went 120 feet in 12 seconds. When we fly an X-43 at Mach 7, we can go about 16 miles in 12 seconds."

His colleague Ken Rock grins wide and jokingly applies Einstein's theory of relativity: "At that speed you'll be younger when you get off."

The first era of aviation, like any new technology, was marked by unbelievable leaps forward," says Phil Condit, chairman and CEO of Boeing. "How high? How far? How fast?" The next generation of flight technologies may be less dramatic but no less important. Condit says one that will soon improve is the ability to stay connected to the world. "So you're not so isolated," he says. To that end, Connexion by Boeing, a Web and e-mail service, will soon allow passengers on Lufthansa, SAS, and a few other airlines to stay in touch with people on the ground.

Connecting people is what commercial flying is truly about. Tomorrow's technologies, from longer-range airliners to hypersonic jets to tilt-rotors, aim to bring us together more quickly, efficiently, and safely. That simple fact is as important and wonderful as any aspect of this marvel we share with the birds. □

WEBSITE EXCLUSIVE

The sky's the limit online. Interact with 3-D re-creations of famous aircraft. Then join our forum to discuss aviation at nationalgeographic.com/ngm/0312.



AND STILL THEY ANN



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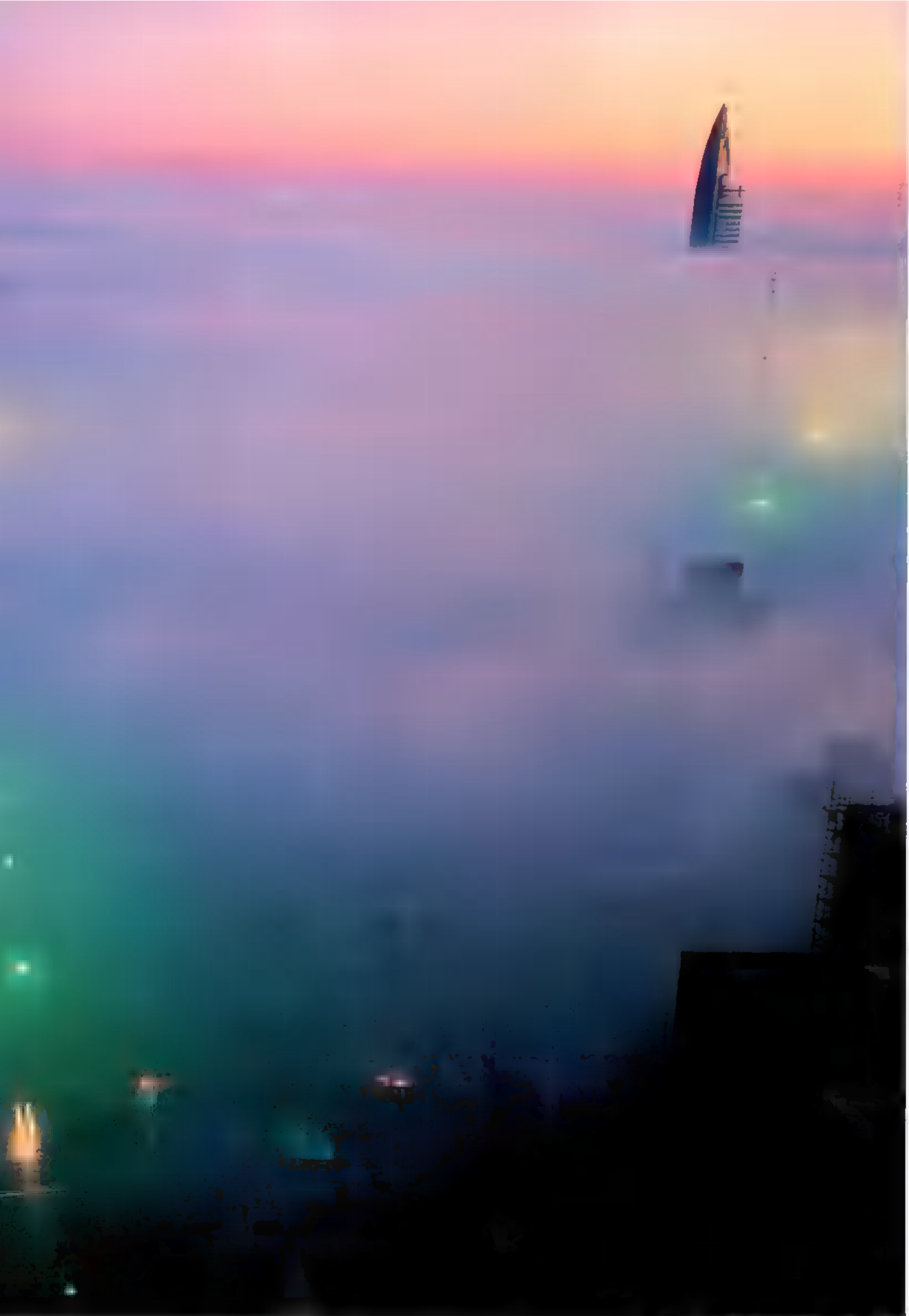
BY ALMA
GUILLERMOPRIETO

PHOTOGRAPHS
BY PABLO
CORRAL VEGA

*Sensual. Moving.
A way to mourn,
or to escape. Such are
the allures of tango,
the salacious dance
and somber song of
Buenos Aires bordellos
in the late 1800s.
Today, in an Argentina
stinging from economic
collapse, tango's
age-old themes remain
unblemished:
Remembering love,
lamenting loss.*



Engulfed in predawn mist, tango's second home—Uruguay's capital, Montevideo—lies just east of Buenos Aires, across the Río de la Plata ("river of silver"). The sister ports are tied by more than proximity:



*They share financial ups and downs, European heritage,
and a devotion to tango that shapes their urban souls.*

ESCAPE



A rainy day leaves empty tables, but the show goes on as Natalia Pastorino and Alejandro Nievas tango at El Balcón, a club in Buenos Aires's San Telmo district. "There's a lot of sadness in our country," says Pastorino,



"but when you dance, you forget. You focus on your partner, on the music. You dance with your heart."

ROMANCE



Alicia Monti, short black hair, tight pink dress, all sinew and no nonsense, strides like an athlete down the hallway of the Abasto shopping mall in five-inch patent leather spike heels, and the few shoppers in sight step aside respectfully at her approach. It is 7:25 p.m., and

she is headed down the marble hallway past the shoe stores, the discount kitchen goods, and the food court to the mall's central plaza, where the Tuesday tango class she and her partner lead will begin in precisely five minutes. Already, hallowed tango recordings are blaring muddily from the speaker system, and on this chilly evening a couple of dozen men and women of all ages—some in pairs, some alone—are shedding their coats and woolly scarves, smiling, eager.

Monti's partner, Carlos Copello, appears moments later, a trademark raffish smile lighting his path. Pomade makes his hair shine like patent leather, his double-breasted suit is a moving sculpture, his gliding, merry walk a dance in itself. The students move toward him expectantly. They are very different in appearance from their dazzling instructors: Most are wearing tennis shoes or

moccasins. A couple of the men have grimy hands from work, and their clothes look cheap.

Following Copello's cheerful, bantering instructions, the men pair off with their wives or friends or perfect strangers. Copello places his right hand around Monti's back and brings her right hand up in his left one, and the students do likewise. Copello holds Monti firmly but at a distance, as if the two were squeezing a third person between them, and the others try to imitate the couple's stance. Copello tells the students to straighten up, keep their eyes off the floor, stick to the eight count.

The music starts. Who could predict that in such a setting magic is about to take place? And yet the dancers' secret life is about to begin: The tango of heartbreaking grandeur, impossible love, commingled breath, intertwined legs, is about to happen in a shopping mall, as it has been happening every day for a century now somewhere in Buenos Aires. "My beloved Buenos Aires," the tangos say, "*mi Buenos Aires querido.*" The couples struggle to connect. One partner cannot move without the other, but no word can be exchanged. Only the man's hand tells the woman where to move, and the legs tell each



IN PERFECT HARMONY

José Libertella (opposite, left) and Luis Stazo of Sexteto Mayor roll out passion from the bandoneon, the squeeze-box brought to Argentina by European immigrants that gives tango its distinctive sound. As divine for the feet as for the ears, the timeless melodies propel bodies onto the floor at a Buenos Aires milonga (tango session), where lovers and friends pivot and glide away the afternoon.

other what to do, thigh to thigh. One, two, three, four, FIVE. *Buenos Aires, mi Buenos Aires.* A very young man wearing tennis shoes and a woman in moccasins are grinning happily. They've just figured out the coordination of the basic step, and now they're circling counterclockwise in harmony around the floor.

Nearly a century ago the tango took over Buenos Aires. Today it remains at the center of the emotional life of *porteños*—the inhabitants of the port city of Buenos Aires—because the music's heart-broken, soaring, yearning lyricism is part of the essential definition of what it means to belong to this much abused, resplendent city. Indeed, there seemed to be a renewed interest in the tango in the dark days of 2002: After a brief economic bonanza in the early '90s that filled Buenos Aires with glitz, the most severe economic crisis in Argentina's history pushed half the population below the poverty level. Yet even as they struggled to pay their utility bills or avoid eviction, many people found new meaning in a music—and a dance—that was neither easy nor frivolous. It suited the times.

A mall seems like an odd place to learn a ballroom dance. The neon logos of fast-food stalls reflect like puddles on the polished floor, and anyone looking for a tuxedo or an evening dress will not find them here—the stores specialize in street fashion. In reality, though, the newfangled shopping center is full of the tango's ghosts. It was built only a few years ago in the shell of what was once the city's central market (Mercado de Abasto), in what is still a working-class neighborhood. Toward the end of the 19th century a flood of European immigrants, the largest number of them from Italy, settled in Argentina, and a great many of them found or invented work for themselves in this market and its environs. With their melodic singing—operatic, one might say—they enriched what was initially a plain music and a roughhouse dance: the tango.

Buenos Aires consolidated its identity as an immigrant city, and by the 1920s the tango was its accepted music. The circle dances of freed African slave communities provided a strong rhythmic underpinning, and a German bellows instrument—the bandoneon—contributed the unmistakable mournful wails and underlying *whump-whump-whump* of the classic tango sound.

The music was also influenced by the world-weary style of the French music hall, in large part, it seems to me, thanks to one Charles Gardes. He was born in 1890 in France and was brought to Buenos Aires three years later by his mother. He became known to the world as Carlos Gardel, the very embodiment of Argentina's romance with song. A brilliant singer and composer, Gardel transformed the tango from a racy bordonero form into an enduring lament. He sang of everything his fellow immigrants might have lost during their voyages: a homeland, parents, the street where they were born. In his clear, lyrical baritone he sang of Buenos Aires's vanishing semirural outskirts and mockingly—constantly—of porteños' struggle to become respectable by dressing up. Unforgettably, he sang of what makes

humans grieve everywhere: failure, the passing of time, the death of love and trust. *I know that life is but an exhalation, that twenty years are but an instant . . . I live with my soul fixed to*

a gentle memory whose loss I mourn again.

Gardel served a long apprenticeship singing in the tough bars and restaurants of the Abasto, and then he became a star of such magnitude that he is to this day practically the only national figure the quarrelsome Argentines unanimously revere. (As do the Uruguayans, who continue to claim him, and the tango, for their own.) Gardel incorporated new lyrics into the old bawdy tango tunes and made them so refined, erotic, tragic, and daring that tango poets soon began writing this new kind of tango especially for him. By the time he died in a plane crash in Medellín, Colombia, in 1935, Gardel had composed dozens of songs, recorded hundreds of others, and made eight feature-length movies.

Gardel might have been remembered simply as a great musician, except that, by turning dress suits and camel-hair coats into his official costume, he also defined classic Argentine style. His hardworking, swarthy fellow immigrants were looked down on by the fair-skinned ruling class and referred to spitefully as *negritos* and, more

tolerantly, as *morochos*, or dark-skinned people. Gardel himself was known throughout his life as the "morocho from the Abasto." Nevertheless, he wore a tuxedo like nobody's business, and his high-gloss flair offered the Italian and Spanish and Middle Eastern immigrants a way of looking that was smooth and strong, like Alicia Monti's stride; slick and debonair, like Copello's sharply pomaded hair and his devil-may-care smile; and killingly urban, like Monti's high heels and like Buenos Aires itself.

Some hours after the end of tonight's free class, Copello and Monti will bring the house down during their floor show at Esquina Carlos Gardel, an elegant dinner theater for tourists housed in an old canteen across the street from the Abasto shopping mall. But for the moment, the pair have their students and a few shy passersby locked in hypnotic fascination as they demonstrate a step: Copello nudges his right knee into the inside of Monti's and pushes her torso slightly leftward with his right hand, forcing her to step back and behind

EMOTION IS WHAT TANGO

herself. In four steps she circles around to face him again. The mechanics are more or less clear; the effect when they put the steps together is wonderful and mysterious. Copello is the effortless center of Monti's gravity. He pushes her slightly away, and she spins around immediately in order to face him again: Here I am. He steps backward, and she follows urgently: Don't ever leave me. He leans toward her, and she leans back, the tough, short-haired woman suddenly pliant as a willow: I am yours.

Tango is not designed to bring out the inner feminist. "I like that fantasy of total subjugation the tango has, like you see in the movies," Monti will say later. "When I dance, my partner is my

ORIGINS

Carefree smiles and bright T-shirts enliven an abandoned factory in a city slum in Montevideo. In the late 1800s tenements here and in Buenos Aires housed freed African slaves, gauchos from the interior, and European immigrants, mostly Italian and Spanish. As these cultures melded in close quarters, the root form of the tango arose.



Humphrey Bogart, my Carlos Gardel. Modern girls say they want independence, but I like the feeling of mutual surrender. That's what I dance for." That's what brings the house down, too, during the duo's floor shows across the street, even though performance tango can look overly dramatic and stiff—stagey, in other words.

The real dance survives in ordinary men and women of all ages who, as Monti has, decide to live out the fantasy of total surrender in their own person. To that end a number of part-time, barely profitable venues have been set up by tango-mad porteños. They are called *milongas*, or tango sessions, and one of the reasons so few tourists can be found at the best ones is that, in the time-honored way of all Buenos Aires nightlife, they generally get started some time after midnight.

On Thursdays at Salón Canning, a milonga in north Buenos Aires, fashionably dressed Argentine couples and tango study groups from abroad gather to watch experienced tango dancers take the center of the floor. On Saturdays around 2 a.m. at the Sunderland, a neighborhood athletic club in one of the outlying barrios of

the city, whole families sit at plastic tables placed around a basketball court and devour platters of grilled meat, ravioli, caramel cream layer cakes, before getting down to the business of dancing on the court floor. Most tango dance sessions take place only once or twice a week, and die-hard *milongueros* rotate from one to another every evening, Sunday through Saturday. They dance mostly to recorded music, but sometimes a small, skillful tango orchestra plays for a couple of hours somewhere between 2 and 3 a.m. To connoisseurs, the milongas are as distinct from each other as different varieties of fine wine, and someone who likes to show up for the elegant, jivey, late Friday-night session at Gricel, say, will avoid the staid, old-fashioned early Saturday session like the plague.

El Beso, a little milonga done up in cheerful shades of green and red, starts early on Wednesdays. This evening unattached men and women sit separately in groups on opposite sides of the dance floor. The men, many dressed in black pants and shirts and smoking nonchalantly, look in command. The women look impossibly glamorous in high heels, tight short skirts, skinny tops all done in glitter. One of the men nods in the direction of a woman sitting at a table

IS ALL ABOUT.





Feelings flow like wine at Lo de Roberto, where locals step up to share life lessons through soulful songs. Early tango lyricists wrote in expressive Lunfardo, a Buenos Aires slang reflecting the gritty urban themes



of betrayal, poverty, and misery. But tango sometimes hits a sweeter note, with tunes that uplift and lyrics of celebration rather than defeat.

SOUL



THE DANCE OF AGE-OLD DESIRES

across from him. The woman catches his glance, smooths her skirt, waits for this partner to cross the floor. Who knows if they have danced together before? They sway gently in each other's arms for a few seconds, absorbing the music, and then the dance is on—three minutes in which a man and a woman hold each other in a trance. The music ends, the man walks the woman back to her table and then returns to his own, where a bucket holding champagne on ice is waiting.

Music, champagne, beautiful women, gorgeous men, perfume that drifts through the air like a song, songs that linger in the mind like perfume. The union of two bodies transformed into one? Total subjugation? My Humphrey Bogart? I decide that it's high time to sign up for tango lessons.

One, two, three, four, FIVE—the successful resolution of the tango's basic eight-count step for women depends on one's ability to cross one's ankles tightly, left over right, on the "five." This is a reasonably simple task if one isn't

concentrating simultaneously on keeping the right shoulder down, the right elbow up, the left hand relaxed as it holds on to the partner's back ("it's an amorous embrace," someone suggests unhelpfully from the sidelines), the torso facing straight forward, the legs stretched and long. "Try not to bounce up and down," my teacher, Luis Lencioni, suggests gently. I straighten up, and trip over his right foot, then the left.

"Worse things happen," he says with a wink. "Try not to look at the floor," he adds, dragging me along. "And when you step, don't pick up your feet like that. Try to slide." Rather than becoming one with Lencioni, I feel as if I were turning into a rather large ostrich in his arms. Much of my early youth was spent in modern dance studios, training to become a professional dancer, but those years of effort are not paying off here. We stop, and Lencioni repositions me. In the tango the woman's torso remains facing strictly forward under all circumstances, focused completely on the man. The hips may swivel, but they *never* move side to side, as in



NOWHERE ELSE TO GO

“Tango is therapy,” says Jorge Martorello (opposite), practicing a dance pose at the well-known Rodolfo Dinzel studio in Buenos Aires—a place offering both solace and job training when many must eke out life on the streets (above). But the worst may be over for Argentina, a country now struggling to stand in the aftermath of its 2001-02 economic crash, which pushed half the population into poverty.

AND TORMENTS

salsa; instead, the entire lower half of the body twists left or right in a single block, and one moves about the dance floor in this fashion, like a character in an Egyptian tomb painting.

“Always so?” I ask Lencioni, doubtfully.

“Always so.”

Soon enough I trip once more. He reassures me again and keeps on dancing manfully until eventually I begin to feel a connection with the music, a certain surrender to the steps, a relaxing sense of floating along with my partner. Lencioni brings me to a full, sharp stop. “Get some personality in there!” he scolds. “Don’t just moon about enjoying my dance!”

In other words, technical clumsiness is forgivable; emotional sloppiness is not, because emotion—strong, intense, focused emotion—is what the tango is all about. I promise to do better in the next tango, but my back is killing me from all the corkscrew swivels of the previous one.

Luis Lencioni more or less keeps things running most afternoons at the tango studio of the legendary dancer Rodolfo Dinzel, an iconoclast who has written about the art of this dance

carefully and with obsessive attention to its detail and hidden meanings.

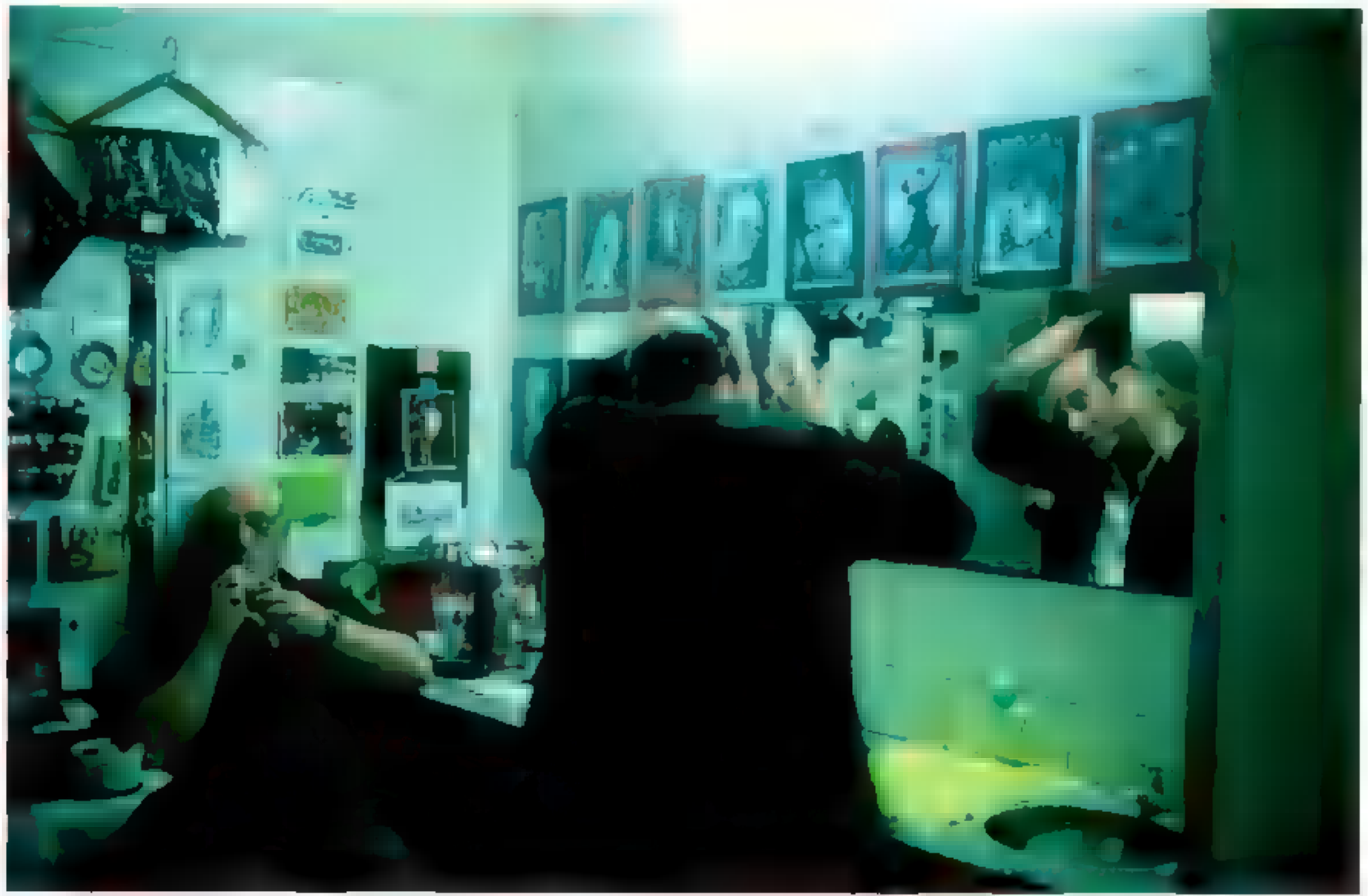
I ask Lencioni what people who want to learn the dance come looking for.

“Company,” he says. And then, repeating what I had heard already many times, so baldly that it made me blush, he explains further. “Each tango is like having a girlfriend for three minutes. A woman gets to hold a man. It’s the embrace, no?”

Mariano Nouzeilles, who shows up almost every day at the studio, initially came looking for simple human comfort. He is a slight young man with beautifully chiseled features, who apologizes each time I stumble over his feet when we take a turn around the floor together during my second class. Later we get to talking, and he tells me that a year ago, during the mass firings that took place at the height of the economic crisis, he lost his job in the sales department of the Renault truck division. Unemployed since then, he gradually became anorexic with worry, lost his girlfriend and his apartment, and eventually had to move in with his brother.

He was 28 then, and because he had been working steadily since the age of 16, he had no studies or special skills, other than selling. Adrift,





COMING ATTRACTIONS

A standout in black, tango singer Laura Bogado touches up and winds down with folk dancer Nora Mendoza between shows at El Balcón. Men also perform, preening in the men's room of Niño Bien (above) before trying to win a heart—or at least a dance. Carlos Ferrara, at left, sells cigarettes, mouthwash, cologne, and tango trinkets to patrons; the love advice is free.

he turned to the tango. He felt bitter and betrayed by fate, he says one day in a taxi when I offer him a lift downtown, and it seemed logical that he would find comfort in the very bitterness of the tango's lyrics, its all-encompassing despair. *I know, don't tell me so—yes, you are right! Life is but an absurd wound*, one classic says. It fit: At least he had a music for his sorrow and lack of hope.

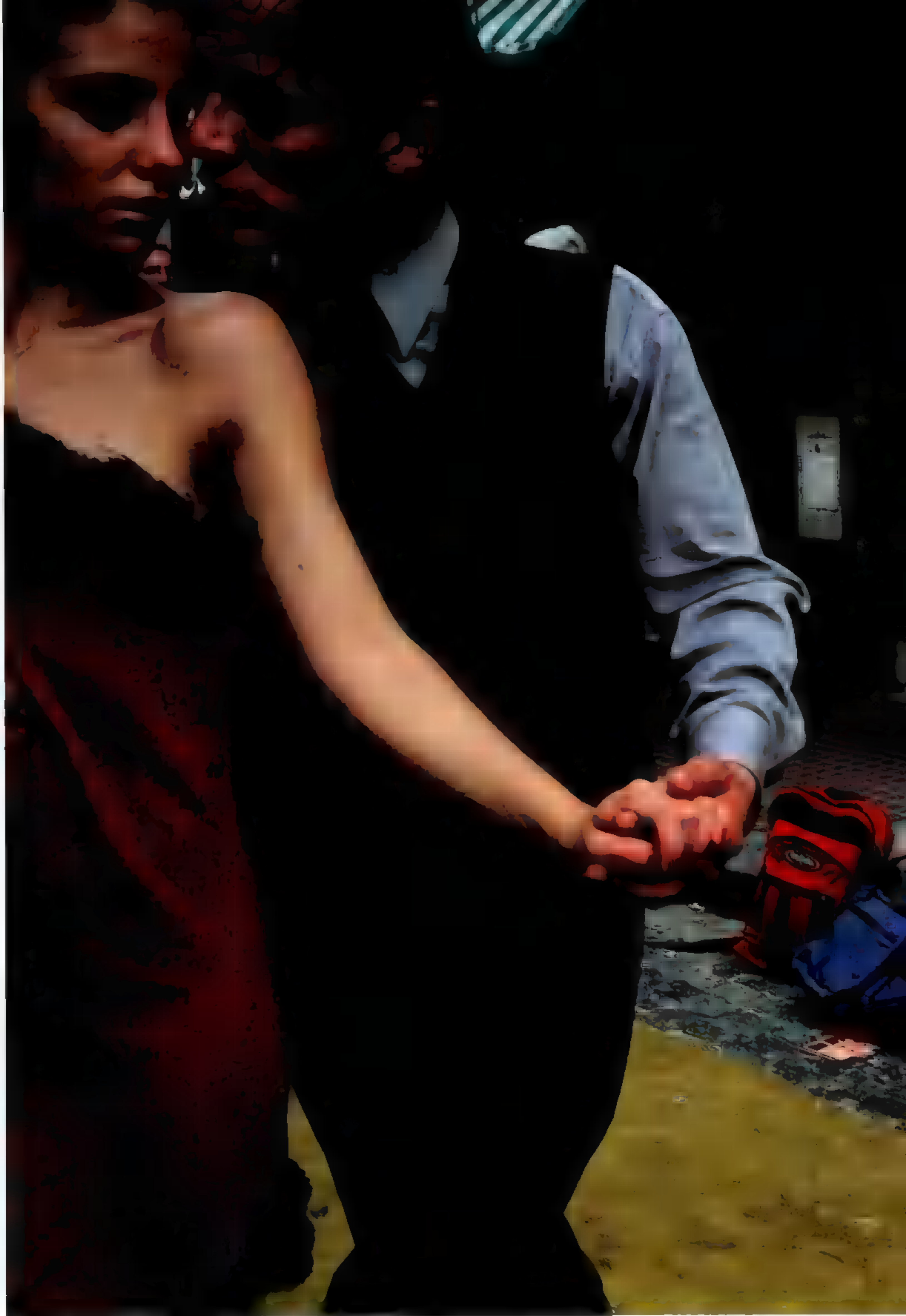
But the tango has also been good to Nouzeilles. During our second conversation he tells me how, after his first few weeks of lessons, he fell in love with a fellow student. “It wasn’t your typical approach,” he recalls, smiling. “We had to dance together. I said hello, and then I embraced her. Before we had even had a conversation, I realized that, in the steps, we understood each other.” The young woman, who is a psychologist, emigrated to Canada a few weeks after Nouzeilles met her, but the memory of their weeks together is one of the few things that make his face light up these days.

Soon, Nouzeilles said, he may emigrate too, propelled by his desperate need for a better life. He would like to end up in Italy, he explained, and to this end he was taking language lessons at the Italian Embassy’s cultural institute. The

day I give him a lift I am surprised by how effusively he thanks me, until he explains that most days he walks the 40 or so blocks from the Dinzel studio to the institute.

In the beginning years of tango’s first heyday, epitomized by Gardel, Argentina was living off the fat of an economic boom made possible by its traditional exports of beef and grain. Buenos Aires grew in splendor, adding broad avenues and modernist public buildings to the magnificent turn-of-the-century horizon. General prosperity fueled the music’s second golden age in the 1940s and ’50s, when the great tango halls and orchestras played through the porteño night. It was during this second period that the tango achieved such a high degree of sophistication and beauty that it subdivided: dance and music. Tango addicts argued about which was superior—the music or the dance—and followed their favorite orchestras around like soccer hooligans.

Back then it was normal to see workers at a construction site set up a pampa-style open grill to prepare huge slabs of meat for lunch, which were consumed with a couple of glasses of hearty Argentine wine. The rich traveled to Europe for



Street dancers sizzle in San Telmo, putting private moments on public display—theatrics that keep donations flowing from passersby. The number of visitors to Argentina from abroad rose by 58 percent in the past



decade, peaking at three million in 2002 as the nation's currency slumped. The sweet temptress tango helps keep them coming back.

DRAMA

their outfits, while the middle classes did very well in the fashionable boutiques on Florida Street. Around the corner from the pedestrian shopping paradise on Florida, afternoon tango dances were held in mirror-and-gold-leaf cafés like the Ideal and the Tortoni.

Argentina changed dramatically after World War II. Unemployment became chronic, political regimes increasingly unstable, and even in night-loving Buenos Aires, fewer and fewer people ventured out to live the evening's adventures until dawn. In the 1970s the international rock-and-roll juggernaut shut down most of the local tango recording studios. Tango dance halls gradually closed down, tango orchestras almost disappeared. The great Astor Piazzolla wrote vanguard tangos in the 1960s and '70s that no one wanted to dance to, composing, in effect, a magnificent epitaph for the union of dance and music that had given birth to the tango long ago.

"A music that started out for the feet ended up being for the head," says José Libertella, at 70 probably Piazzolla's most soulful interpreter and

reborn vitality after the inevitable passing of the music's elder statesmen. "The day my fingers give out and I can no longer play the bandoneon, I won't worry," he says. "There's a great number of young people who are excellent musicians and who are standing ready to take over. Thanks to them, with their new style and new compositions, the tango will acquire a renewed urgency."

At 2 a.m. at a milonga held at the Centro Cultural Torquato Tasso, I wonder if the singer on stage, Daniel Melingo, is what Stazo has in mind. Melingo, a former rock musician who has perfected a hoarse, more-wicked-than-Mick-Jagger style of performance, sings tangos about cocaine and men who beat up women, or worse, and his cult followers love it. They are under 30, by and large, and they probably couldn't care less about the hallowed forms of tradition, but Melingo honors that tradition carefully, rescuing underworld classics about the underbelly of Buenos Aires nightlife. *And while he kissed her brow ever so fondly, he stuck her with the knife thirty-four times.* The rest of his repertoire

TANGO SURVIVES IN ORDINARY MEN

like him, a master of the bandoneon. When Libertella started the Sexteto Mayor with fellow musician Luis Stazo in 1973, most people under retirement age considered the tango to be nothing more than a kitschy relic.

"Stazo and I each had our own groups, but neither of us could afford to keep going by ourselves any longer," Libertella says of that period. "We didn't know if we'd survive 30 days, much less 30 years."

The first year was hard, but in 1983 he and Stazo were saved by a show that started in Paris and triumphed on Broadway—*Tango Argentino*—featuring the Sexteto Mayor and six couples with no formal training who swept the audience off their feet every night with their spectacular dancing. A few years later, due in part to the show's influence, an all-tango radio station, FM Tango, made its debut on the airwaves, leading a new generation of Argentines to understand what it was that had so passionately moved their parents. Today the Sexteto tours Europe regularly and appears often in the U.S.

Stazo is certain that the tango will retain its

consists primarily of his own compositions, with knife-edge lyrics provided by a friend.

"I think the tango's survival depends on new composers, not interpreters," he says during a conversation one afternoon, at home in the quiet neighborhood where he and his wife are waiting for their first baby. "I personally don't get any benefit from listening to the 30th different interpretation of 'Uno'"—a classic tango. "What we need are new authors for new tangos, because the form has enormous potential."

But will you be able to dance to them? Perhaps in the late 21st century there will be a new tango dance, one that reflects new passions and obsessions. For the moment, at the Abasto mall, Carlos Copello and Alicia Monti are demonstrating the dance of age-old desires and torments

UNQUENCHABLE

All-night dancers yield to fatigue, but a new, youthful following keeps tango vibrant. "There's something in you that lives and endures," goes a 1932 lyric about the beloved tradition. "Song of Buenos Aires . . . now grips the world."

for the benefit of their students. Chin up! Legs straight! Show some passion! Concentrate! The Abasto classes are in their eighth week now, and word has spread that this is a place where you can dance for free. Accordingly, on this Tuesday in October there are some 30 couples crowding the dance area. An informal visual scan determines that many of them don't need classes. An informal poll establishes that, with five exceptions, at least one person in each of the couples is unemployed.

Tulio Tochia, who shows up every Tuesday, has some sort of a job, he says, although it's hard to imagine why anyone as beautiful as he should have to stoop to any kind of labor at all. He has eyelids like Greta Garbo, a classic nose, silver hair. He wears an old, expensive ascot with weary elegance. He quit dancing the tango cold turkey for 26 years, he says, because he realized it was a vice that had already undermined his life. He prefers not to say what he did in the intervening years and what, exactly, he means when he says that he now works as a "peón." Perhaps he carries buckets of cement back and forth at a

construction site with the same careless grace with which he is now dancing with a friend's ten-year-old daughter, who could win contests. Tochia guides the little girl through a couple of complicated turns and figures and hands her back to her proud mother with exquisite, amused, courtesy.

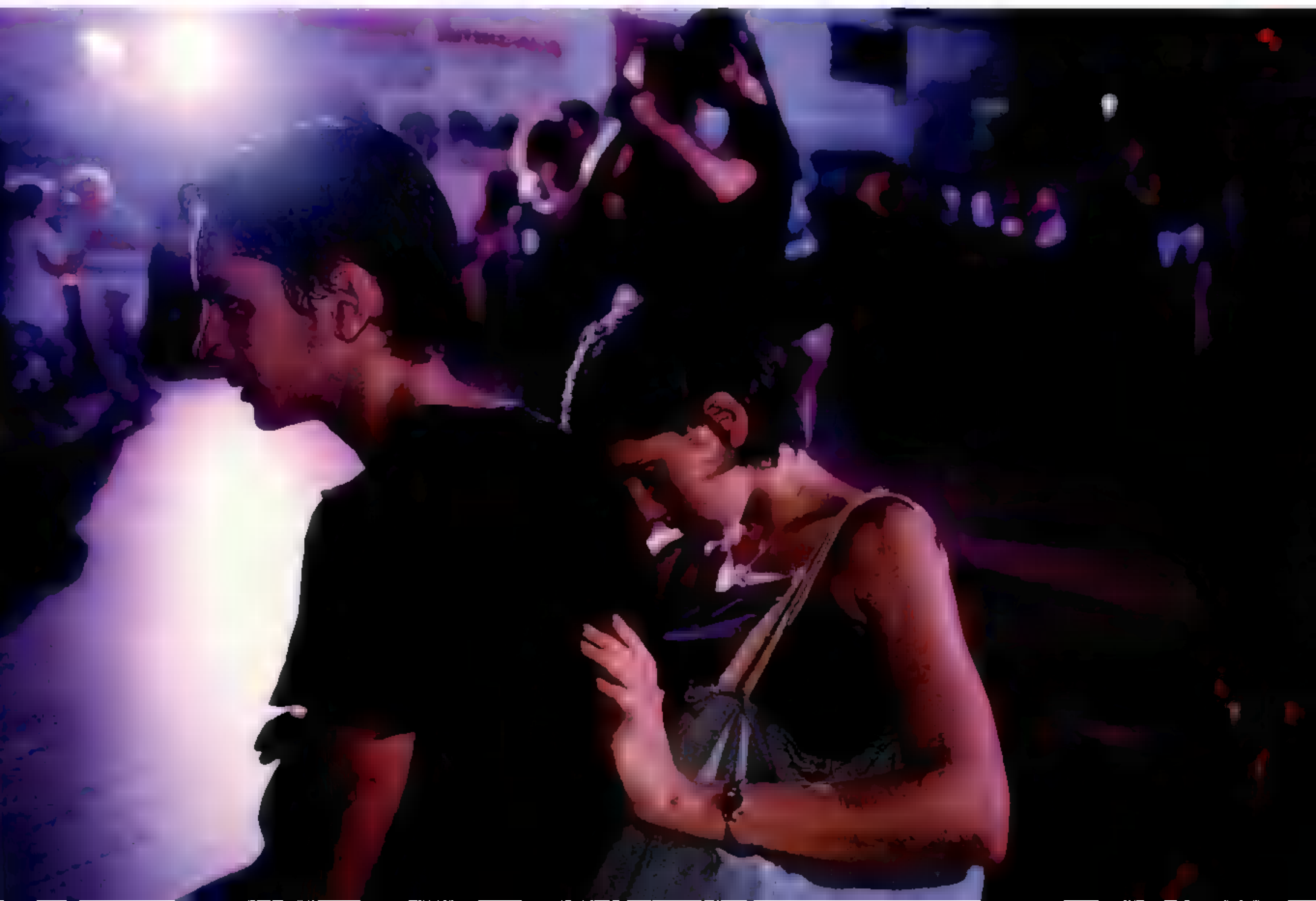
"I had stayed away from the tango all those years," Tochia tells me. "And then one evening I agreed to keep a friend company while he went to a tango lesson. Just for the hell of it, I tried a few steps myself, and the next thing I knew I was completely into the dance. I couldn't stop. I thought it was something that had died within me, but really it was just sleeping."

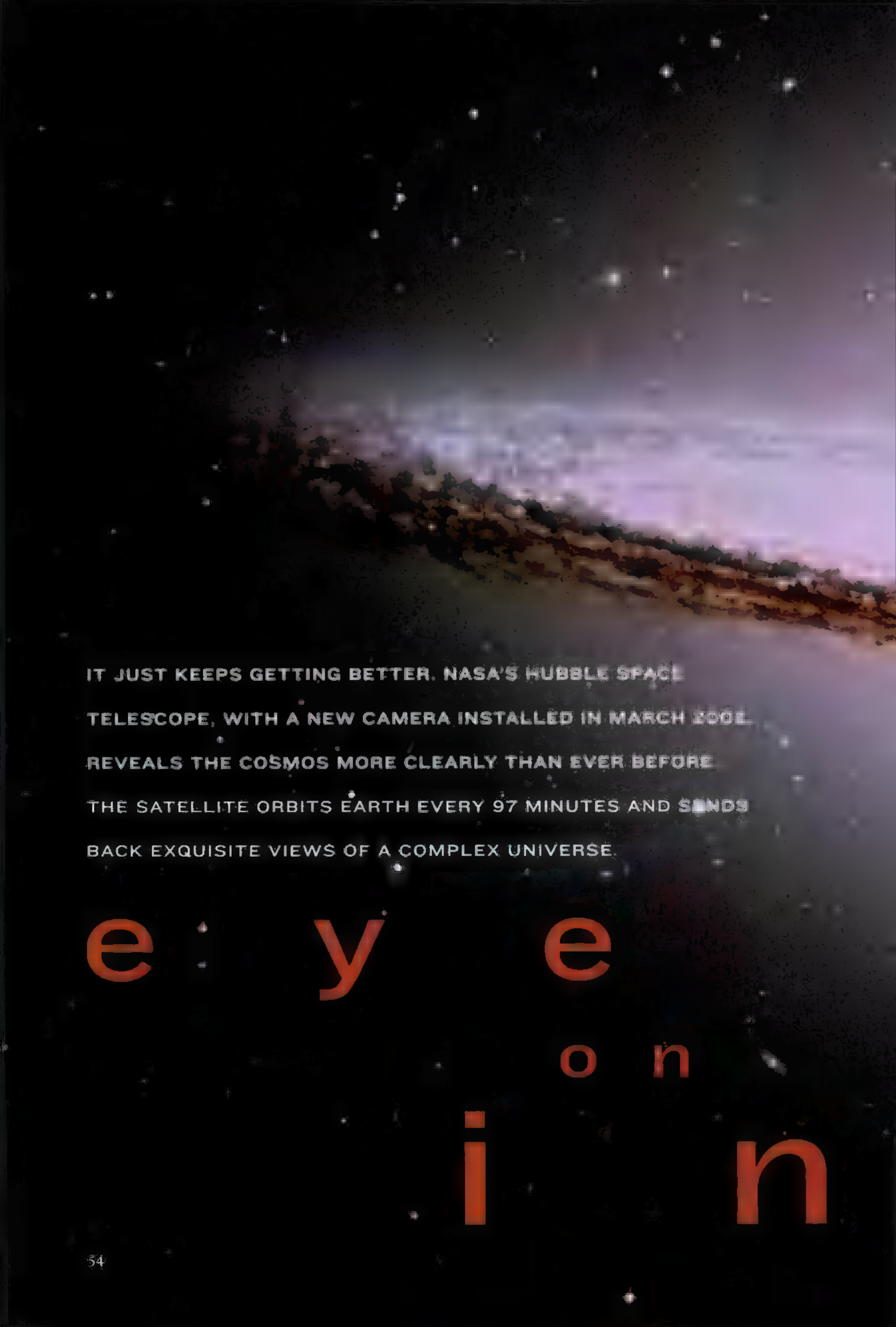
Over in a corner Alicia Monti is working with two little boys and a girl who are making good progress with their basic eight-count step. Copello, as usual, is skimming around the edges of the class area, looking for timid bystanders. When I leave the mall that drizzly October evening, Monti is still smiling, and Tulio Tochia is still dancing. □

WEBSITE EXCLUSIVE

In Sights ■ Sounds photographer Pablo Corral Vega talks about the revival of tango—as much a lifestyle as a dance—at nationalgeographic.com/ngm/0312.

AND WOMEN.



A composite image of a starry night sky. The top half shows a field of stars of varying brightness against a dark background. Below this, a nebula with purple and white hues is visible. The bottom half features a galaxy with a bright yellow and orange core and a spiral structure of brown and black dust lanes.

IT JUST KEEPS GETTING BETTER. NASA'S HUBBLE SPACE
TELESCOPE, WITH A NEW CAMERA INSTALLED IN MARCH 2002,
REVEALS THE COSMOS MORE CLEARLY THAN EVER BEFORE.
THE SATELLITE ORBITS EARTH EVERY 97 MINUTES AND SENDS
BACK EXQUISITE VIEWS OF A COMPLEX UNIVERSE.

e y e
o n
i n



Just released:
this image of the
galaxy nicknamed
Sombrero, 50,000
light-years across
and brighter than
400 billion suns.

HASAPAGE TELESCOPE
SCIENCE INSTITUTE/ISTSCM
GALILEO HERITAGE TEAM

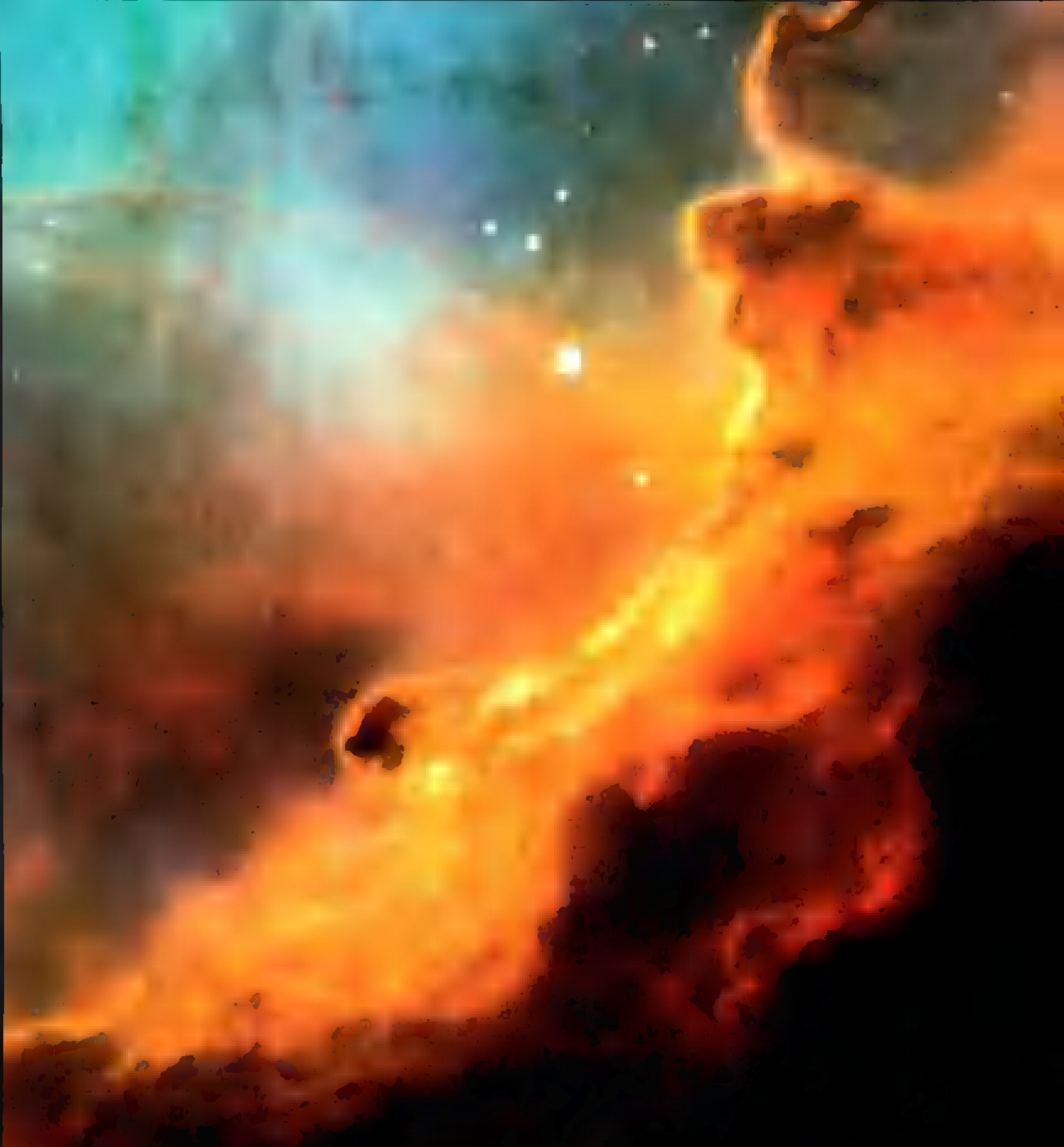
f i n i t y



f i n



i t y



oceans of starlight

Radiation from nearby stars sculpts a rolling wave of gas and dust—a section of the Swan Nebula roughly three light-years across. Hubble's penetrating vision has helped explain how stars are born in such complex regions and has also provided a clearer view of how stars evolve. In a last gasp, the dying star that became the Helix Nebula (far left) expelled its outer layers into space. The remaining core—a white dwarf—irradiates the dispersing gas, causing a fluorescent glow, its natural colors enhanced during image processing. A mosaic of 36 Hubble pictures combined with a wide view from a telescope on Arizona's Kitt Peak produced the image.

NASA/STSCI/JEFF HESTER, ARIZONA STATE UNIVERSITY (ABOVE); NASA/STSCI/MARGARET MEYER AND NATIONAL SCIENCE FOUNDATION/NATIONAL OPTICAL ASTRONOMY OBSERVATORY/TRAVIS Rector, NATIONAL RADIO ASTRONOMY OBSERVATORY (FAR LEFT)

► **WEBSITE EXCLUSIVE:** An animation of the Helix Nebula during this astronomical feature is free at nationalgeographic.com/ngm/0812.

A photograph showing the interior of the Hubble Space Telescope during a servicing mission. The scene is dimly lit, with a bright, glowing light source on the left side, possibly the Earth's horizon. The structure is complex, with various panels, wires, and mechanical components visible. The overall atmosphere is one of a confined, high-tech environment in space.

Service on the Fly

by Chris Carroll

Hubble was built to be tuned up in orbit. But it wasn't designed for the major overhaul NASA astronauts undertook during its fourth servicing mission, 3B, in March 2002. They delved into the telescope's guts during long space walks, like the one shown here illuminated by a sunlit crescent of Earth, and replaced parts that the original designers never thought they'd need to. Installation of a new power-control unit forced an unprecedented and nerve-racking shutdown of the entire satellite—a move comparable to a surgeon stopping a patient's heart during surgery, says Anne Kinney, NASA's director of astronomy and physics. Astronaut John Grunsfeld raced to finish the task before the temperature of the switched-off telescope dropped far enough to damage it. Would it power back up? "When you run a computer for 12 years, you don't know what kind of ghosts you have in the system," Kinney says. When all systems reactivated as planned, the astronauts, as well as astronomers and mission controllers on the ground, breathed a collective sigh of relief. The rest of the mission went like clockwork, including

NASA



installation of a new cooling system for Hubble's near-infrared camera—NICMOS—useful for surveying dusty and cold areas of space, and installation of new solar panels and science equipment.

It was the most challenging service mission ever attempted in space, and its success elated astronomers. Chief among the wonders was the long-awaited ACS, or Advanced Camera for Surveys. It essentially made Hubble into a new telescope. "ACS has roughly ten times the discovery power of the previous camera," says Mario Livio, astronomer at the Space Telescope Science Institute in Baltimore. Translation: Hubble can now see twice as much area with five times more light sensitivity.

Tragically, this mission would be the last successful voyage for space shuttle *Columbia*. The disaster in February 2003 grounded *Discovery*, *Atlantis*, and *Endeavour*, the three remaining shuttles, and will delay plans to bring Hubble a spectrograph and a new wide-field camera with ultraviolet and infrared capability.

EXCLUSIVE

Zoom into the Swan Nebula; explore the twisted disk structure of warped galaxy ESO 510-G13, and examine more Hubble images of deep space at nationalgeographic.com/ngm/0312.



t h e d e e p e n d

Time travel is the essence of this image, Hubble's recent contribution to a multi-telescope sky survey called GOODS, or Great Observatories Origins Deep Survey. Focusing for 90 hours in a single direction over a year's time, the telescope revealed a multitude of faint galaxies more than 12 billion light-years away—nearly back to the big bang itself, which many scientists think happened about 13.7 billion years ago. The survey also shows galaxies much closer to us in space and time, including two, at near right, that may merge. The goal is to understand galaxy evolution, a big step in grasping the fundamental nature of the universe.

APRIL 23, 2003, HUBBLE SPACE TELESCOPE, NASA/ESA





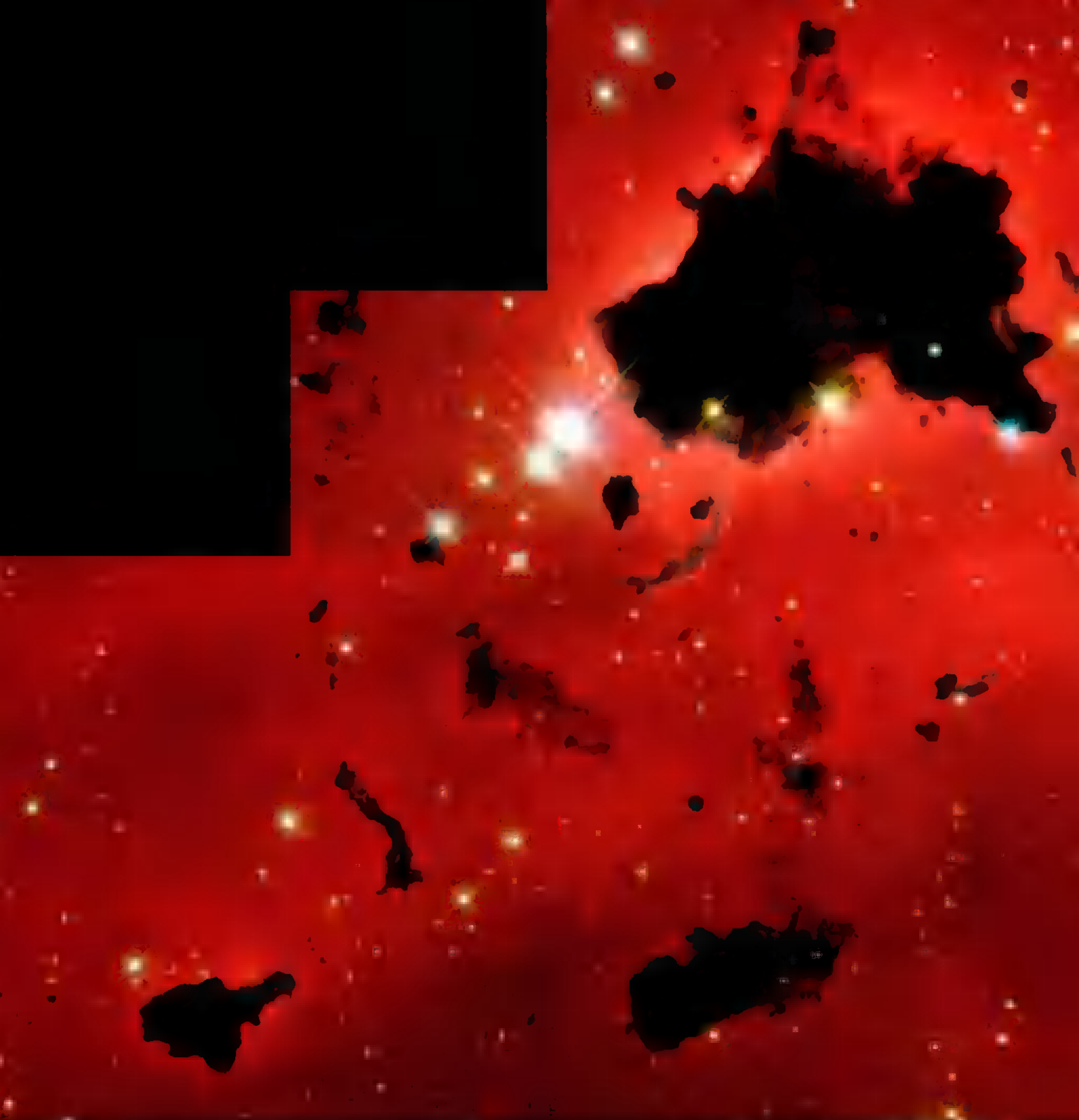
e c h o o f l i g h t

First a mysterious brightening was seen from Earth. Months later, in the phenomenon known as a light echo, shown here, a wave of illumination swept out into the dust cloud surrounding the star V838 Monocerotis. In a trick of geometry, explains astronomer Howard E. Bond of the Space Telescope Science Institute, light continues to illuminate more-distant dust, creating the optical illusion of a ragged, inflating balloon. Hubble recorded these images from May to December 2002.

NASA/STSI/HOWARD E. BOND







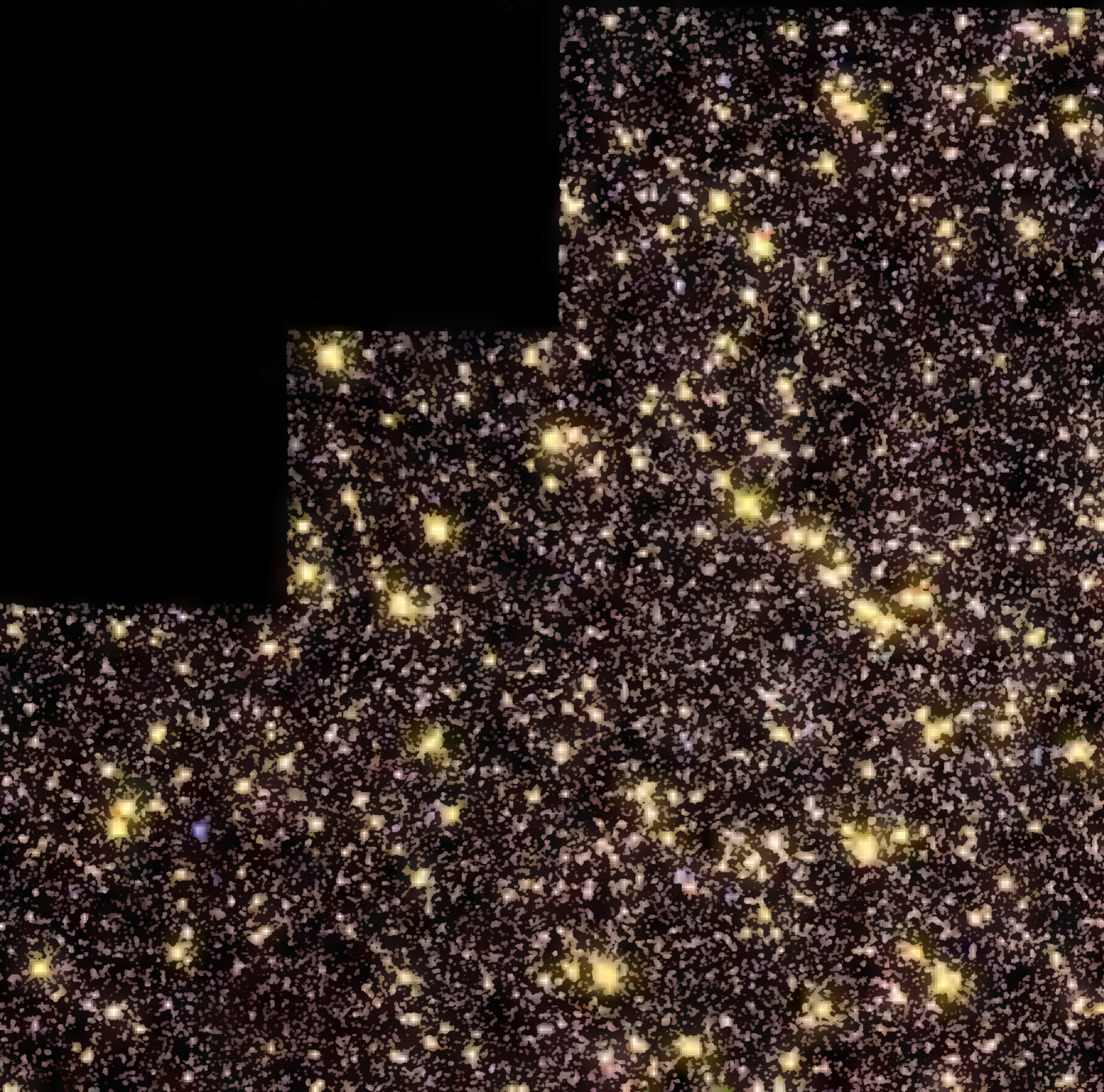
clearing skies

They look like windblown clouds passing overhead on a starry night—dense dust and gas formations in a fertile star-forming region of the constellation Centaurus. Named Thackeray's globules after their discoverer, they are, astronomers think, being shredded by strong stellar radiation. During image processing, scientists added the orange glow to a black-and-white Hubble image to signify the presence of hydrogen. The empty black corners in these images are a result of the camera configuration.

stellar sprawl

Maximum stars, minimum space. That's pretty much the definition of a globular cluster like Omega Centauri (below). Hubble's extreme clarity lets astronomers peer into this central, dense region of the cluster, which contains the oldest stars in our galaxy. Ground-based telescopes, hampered by atmospheric blur, would show little more than smears of bright starlight. In another ancient globular cluster, M4, Hubble recently surprised scientists by revealing a planet that may have formed 12.7 billion years ago—the oldest known to date.

(NASA/STSCI/ADRIENNE DOOL, SAN FRANCISCO STATE UNIVERSITY/HUBBLE HERITAGE TEAM)







c o s m i c b u m p e r c a r s

Majestically, galaxies traverse the heavens like serene pinwheels... well, not exactly. In fact, they zing through the cosmos and sometimes hit one another—which is how galaxies grow. (The collisions take far too long for people to observe.) A galaxy (below) appears wapped because of a recent pileup. Two spiral galaxies (above) appear to collide but are passing some 20 million light-years apart. An unusual ring galaxy, Hoag's Object (above center), may be the result of two colliding galaxies. Older yellow stars reside in the center; a surrounding ring of new stars was created by the disruption. Galaxies in the misnamed Seyfert's Sextet (above left) head for a collision. It looks as if there are five, but Hubble shows clearly that there are really four, one with a tail at bottom right; just above it in the picture, a fifth spiral galaxy lies far behind.

HERITAGE PROJECT (ALL) CLOCKWISE FROM BOTTOM: CHRISTOPHER CONSELICE, CALTECH/HUBBLE HERITAGE TEAM; MILES COPIE, PENNSYLVANIA STATE UNIVERSITY, AND JAYANNE ENGLISH, UNIVERSITY OF MANTOYA, ILL. A. LUCAS/HUBBLE HERITAGE TEAM





new beginnings

In one of the first images from Hubble's Advanced Camera for Surveys, newborn stars shine at the summit of the Cone Nebula, 2,500 light-years from Earth. Hubble continues to push back the boundaries of knowledge. Further upgrades are in the works, and sky-watchers expect to be amazed by a steady stream of spectacular discoveries until 2010—or even beyond. □

NATIONAL
GEOGRAPHIC
RESEARCH AND
EXPLORATION



GRANTEE

William Saturno, assistant professor at the University of New Hampshire and research associate at Harvard University's Peabody Museum of Archaeology and Ethnology

"This mural exponentially expands our knowledge of what the Maya thought important 2,000 years ago."

Sistine Chapel of the Early Maya



At the swirling mouth of the underworld, a kneeling woman presents tamales, sustenance for life. She and other ornately drawn figures—discovered this year—animate an origin myth in a 2,000-year-old painting, the oldest intact Maya mural ever found.

By Carol Kaufmann

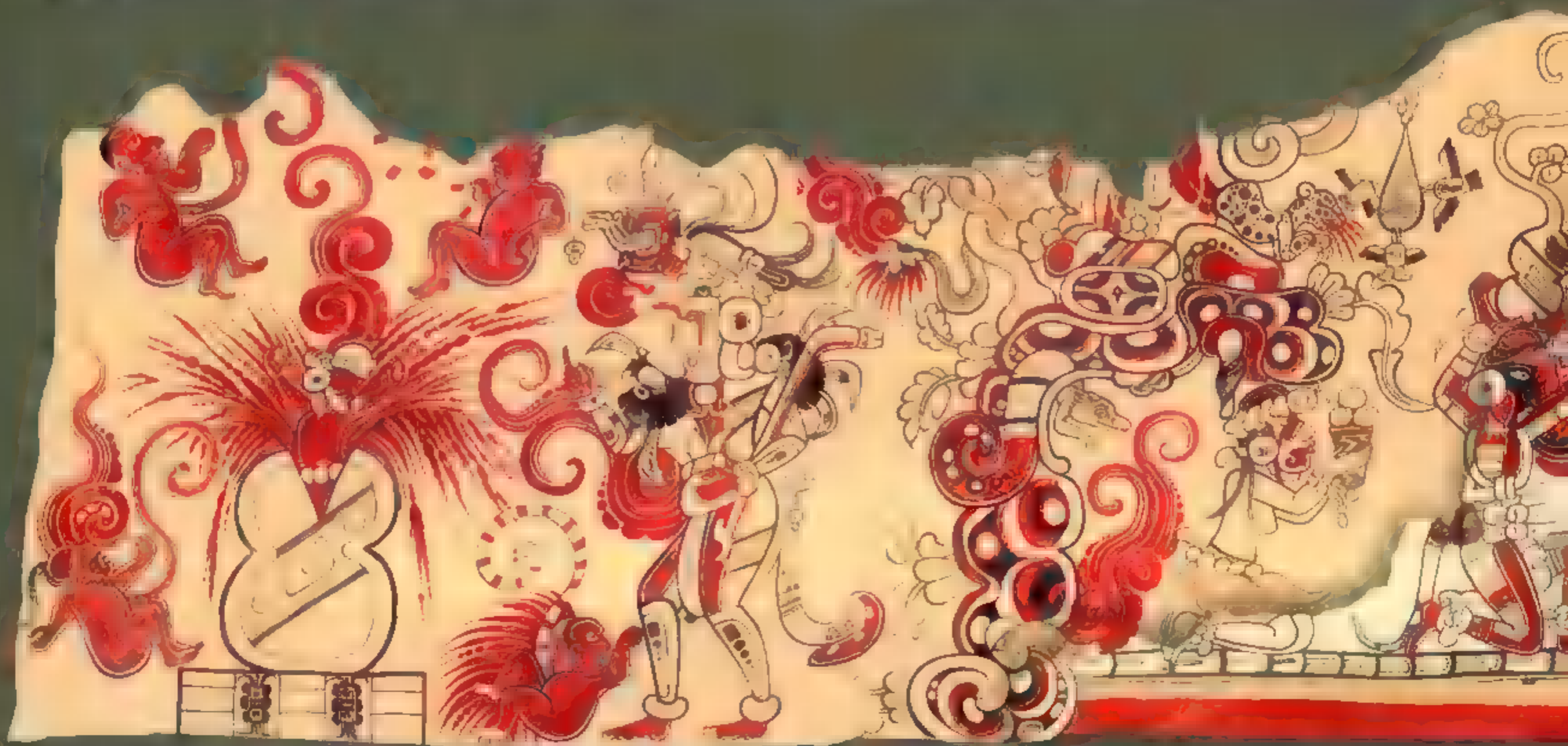
NATIONAL GEOGRAPHIC WRITER

Photographs by Kenneth Garrett

William Saturno is living an archaeologist's dream. Bit by bit, he's unveiling the most elaborate depiction of Maya origins ever discovered, a mural that shows the first known portrayal of the corn god's journey from the underworld to Earth—shattering the time line of early Maya art.

Two years ago in San Bartolo, Guatemala, Saturno spotted a slice of the mural while seeking shade in a looters' trench dug into an unexcavated pyramid. The four-foot-long fragment (indicated at center, below) showed the intricate ornaments and muscled thighs of the corn god, a mythic Maya figure. Suspecting that more of the painting lay behind rubble that filled the dark room, Saturno vowed to return.

In 2002 he mapped the site, and in March of this year he began excavation. Working long hours until his arms ached, he gingerly chipped away at the rocks that obscured the mural.



With a deft touch, Saturno scrapes dirt from the fully exposed north wall, rendered below by artist Heather Hurst. In the fragment found in 2001 (indicated at center), the corn god receives a gourd of water. He swivels his head, preparing to pass it to outstretched hands, a relay to transfer life-giving food and water. This year Saturno revealed new characters. They ride with the corn god atop a plumed serpent—symbol of wind and breath—as it slithers out of sinuous curves depicting Flower Mountain, a sacred place of Maya gods and ancestors.



Precision was crucial: Removing the wrong stone could cause walls to collapse, harming Saturno or the painting. As the room cleared, black outlines and pigments of red and yellow appeared—the creatures and faces of a lost world.

“The first figure we uncovered was the woman with tamales, in gorgeous Technicolor,” says Saturno. “I immediately fell in love.” The mystery woman wasn’t alone. She and others join the corn god on the back of a mighty serpent emerging from

Enthroned on the west wall, a king awaits his crown (below), a pivotal moment when a man becomes royal—or perhaps divine. The scene bolsters evidence of the importance of kingship among the early Maya. “It could portray the first accession of a god,” says project iconographer Karl Taube. Until all the dirt is chipped away, “we can’t say if the king is real or mythological.”

THE PROJECT

DATE: MARCH 2003

PLACE: SAN BARTOLO, GUATEMALA

GOAL: EXCAVATE, PRESERVE MURAL

ESSENTIAL GEAR: CONSERVATION AND EXCAVATION TOOLS, GENERATORS FOR COMPUTERS AND LIGHTS, ANTIVENOM

DANGERS: VENOMOUS SNAKES, DEHYDRATION, COLLAPSING WALLS

a sacred mountain. “The Maya were probably trying to portray the origin of maize and people,” says project iconographer Karl Taube of the University of



Artist Heather Hurst shows Saturno her sketch of the kingly scene (below). “The painters’ line work was so consistent and controlled,” says Hurst. “They were professional artists who had done this many times.”



Update on an Ancient Treasure

No one knows exactly why the early Maya added a mural room (depicted below) to the back of a pyramid. But now Saturno knows the room's size. Authorized by the Guatemalan Institute of Anthropology and History, he and his team dug a tunnel around the perimeter of the structure, which measures about 15 by 35 feet on the outside, roughly 14 by 31 inside. The mural

probably ran along all four walls of the room like elaborate crown molding, totalling 90 feet in length. Saturno has revealed the entire north wall and about three feet of the mural on the west wall—the only walls still standing. The Maya destroyed the other two sides to build a second pyramid over the original structure. To finish the work begun in 2001 (see NGM, April 2002), Saturno and his team hope to clear the rest of the west wall, reassemble the fractured bits, and finally decipher all the mural's secrets.



ART BY HEATHER HURST



Early Date of Wall Art Stuns Experts

Uncovering a Maya Mural

Dated by about 2,000 years to Guatemala, the core and symbols seen in light with the discovery of the oldest known wall painting of Maya mythology



The earliest painted Maya inscriptions ever found (left) lie beside the throne of the king and may contain his identity. Yet only the last symbol, meaning “lord,” can be read. “These glyphs are extraordinarily ornate and don’t conform easily to later Maya signs,” says project epigrapher David Stuart of Harvard University’s Peabody Museum. “It’s unfamiliar stuff”—at least for now.

California, Riverside. “It’s the Sistine Chapel of the pre-Classic Maya world, the most elaborate creation scene before the Classic period.”

Scholars had believed that the corn god myth first appeared in the Classic period, which started around A.D. 250. But artists created this mural before A.D. 100, proving, says Taube, that “this myth is more ancient than we thought.”

Precise brushstrokes, perfectly formed geometric shapes, and lifelike figures lead Saturno to believe that Maya art also began to develop much earlier than A.D. 100. “This mural

wasn’t a practice run, it was a masterpiece.” Yet it appeared in a relatively small Maya town with only a few thousand people. “If San Bartolo had murals this early,” says Saturno, “everybody had them.”

What else will this priceless mural teach? Not even half-finished with his work, Saturno will soon return to resume chiseling. Until then, more clues to early Maya life remain sealed. □

WEBSITE EXCLUSIVE

Want to learn more about this Sistine Chapel of the Maya? See recommended websites and a bibliography at nationalgeographic.com/ngm/0312.



Looking for mates, flamingos strut their stuff in a courtship display on Kenya's Lake Nakuru. Converging by the hundreds of thousands on East Africa's alkaline soda lakes (following pages), the three-foot-tall birds are known as lesser flamingos, the smallest of five species. But they live here in greater numbers than flamingos anywhere else on Earth.



hot pink

AFRICAN FLAMINGOS ON THE MOVE







fleet feet

Flamingos always travel in groups. When faced with danger (or simply



startled, this time by a few gulls), the birds get a running start, then take turns taking wing.

**BY MARGARET
G. ZACKOWITZ**

NATIONAL GEOGRAPHIC SENIOR WRITER

**PHOTOGRAPHS
BY ANUP AND
MANOJ SHAH**

As many as four million lesser flamingos, *Phoeniconaias minor*, live on the soda lakes scattered the length of Africa's Great Rift Valley. Named for the bicarbonate of soda leached from the region's volcanic soil, the lakes' warm shallows encourage growth of spirulina algae—the birds' staple food.



f

or a flamingo, feeding requires a new perspective: upside down. To consume the spirulina algae that is its main source of nutrition, the bird inverts its head so that the bottom portion of the bill faces up (right). This big mandible also works as a float to keep the bill from sinking too far below the surface. As the flamingo swings its head from side to side, its large, thick tongue pumps lake water into the scoop-shaped bill, where a filter of hair-like projections extracts algae. Excess water is then sluiced out by the tongue. Large gatherings of flamingos require

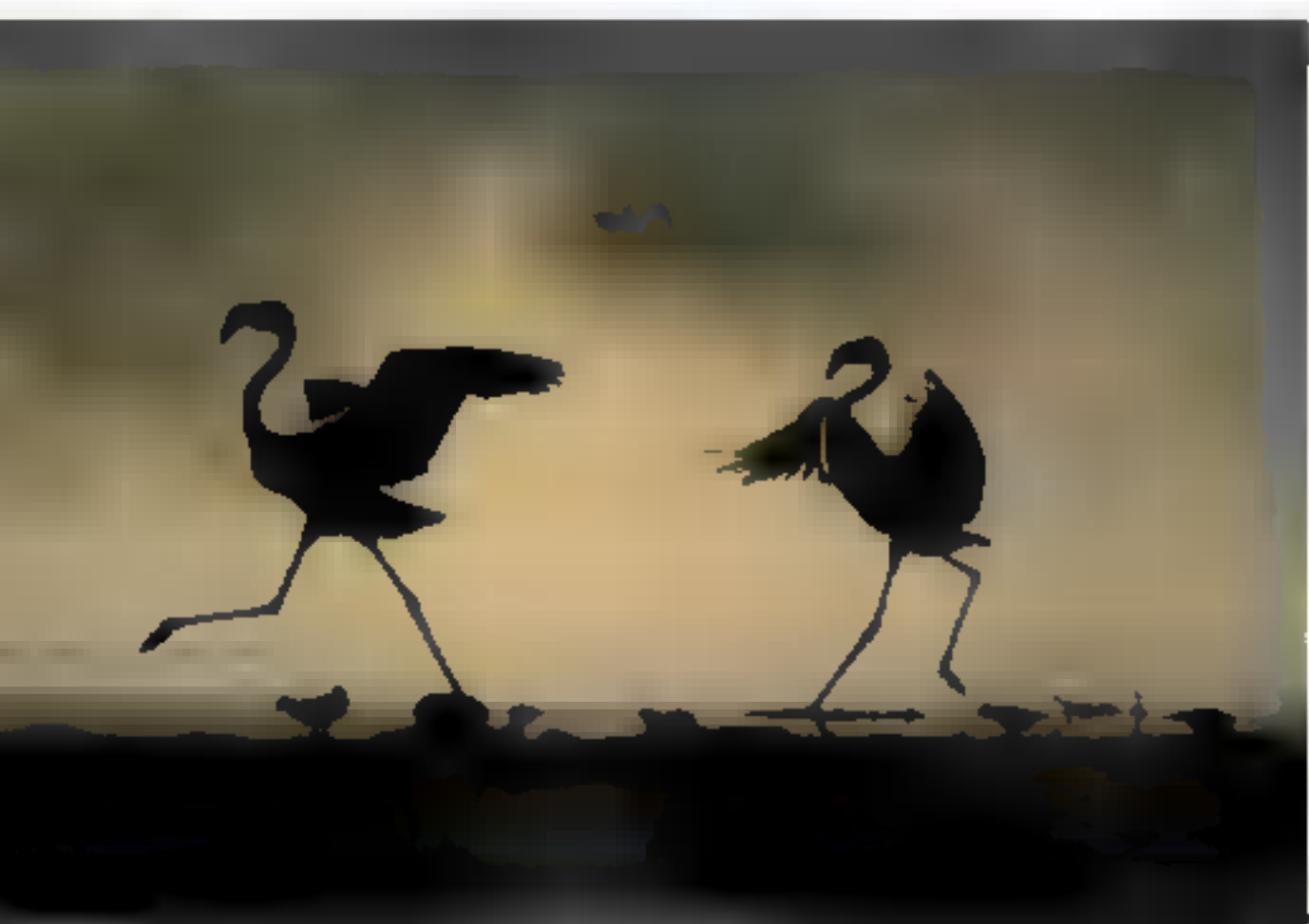
staggering amounts of spirulina. A flock of 100,000 eats 35 tons a day, and flocks of more than a million birds have been counted. But algae blooms are fickle in the Rift Valley lakes; even the most lush spirulina growth can die off almost overnight. When conditions change, noisy pink clouds scud toward the next lake (left). There's no predicting the schedule: Lesser flamingos don't migrate—they wander.







full steam



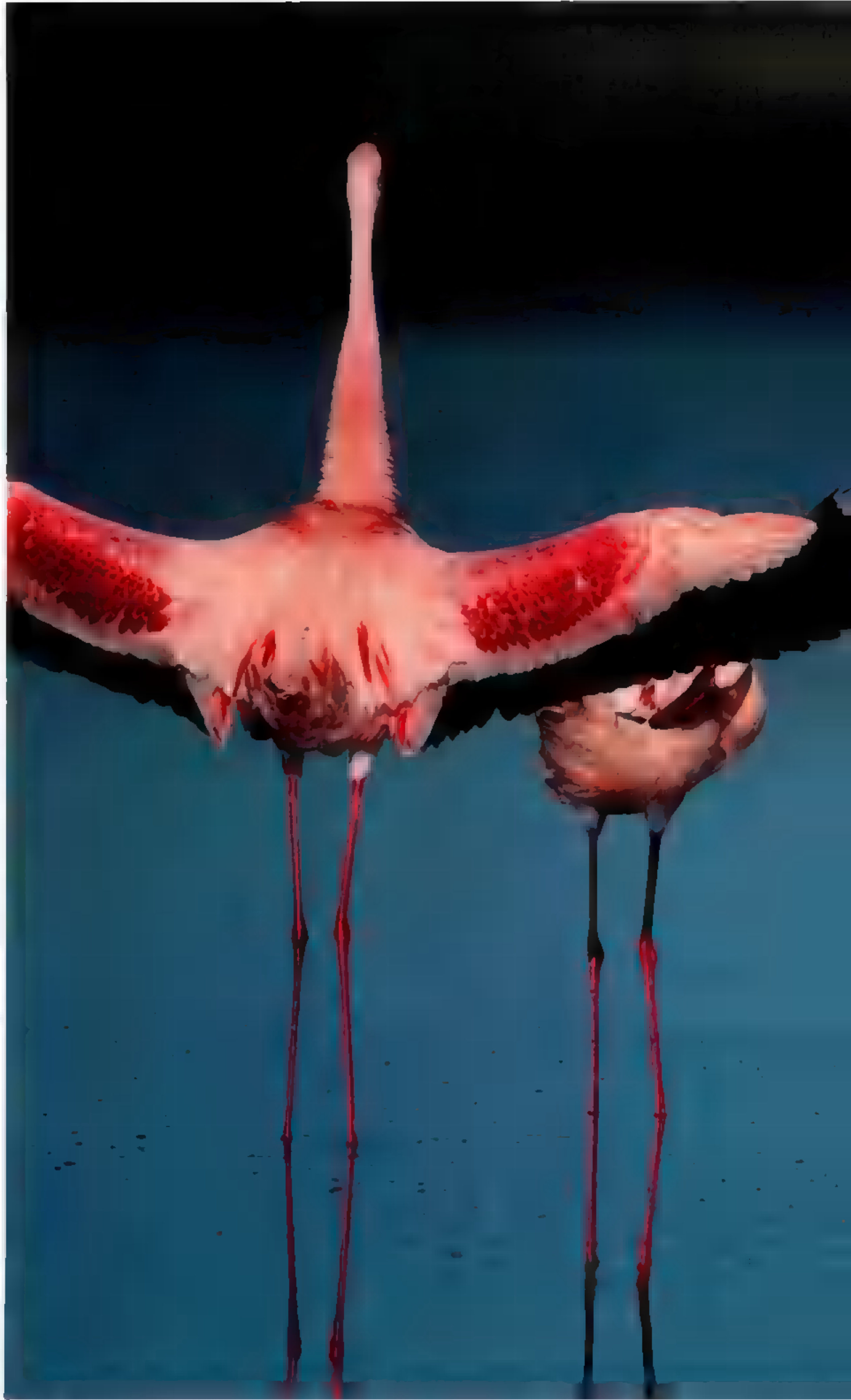
Flamingos wing it over hot spots in volcanic springs (above) and skitter across burning shallows (left) at Kenya's geyser-studded Lake Bogoria. The springs' fresh water emerges at boiling temperature—but it's all there is to drink. Where it cools to about 150°F downstream, the birds form orderly queues (right), waiting their turns to sip the hot water while they splash the lake's

sticky alkaline residue from their feathers. Water elsewhere in Lake Bogoria, away from the springs, can be bitter and caustic and smell of rotten eggs. The salty lake sustains no fish and little vegetation besides spirulina algae. Few living things can endure such conditions, let alone thrive as the flamingos do. Yet the lack of competition for resources lets the flamingo population soar.



**PALE SHAPES APPEAR, THEN VANISH
ONCE MORE, SWALLOWED BY THE CLOUDS
OF DENSE WHITE MIST. —ANUP SHAH**





showtime

True colors flash during a wing salute. Pigments in the flamingos'



algae diet tint their feathers pink. Immature birds and captive adults not fed on algae are pale.



THE FRAGILE BIRD DIDN'T STRUGGLE MUCH. THE SHOCK—AND THE CLAWS IN ITS BACK—KILLED IT QUICKLY. —ANUP SHAH





sudden death

In most of Africa, fish eagles eat what their name implies. But the harsh waters inhabited by lesser flamingos preclude much fish life. Fortunately for fish eagles, the valley's huge flamingo population provides easy prey. One fish eagle watched from the shore of Lake Nakuru for hours before it suddenly took to the sky, then dropped down onto the back of its victim (top left). When a pair of marabou storks arrived to scavenge a share of meat, the smaller bird drove them away (left). Challenges

by marabou storks—two other birds confront a young fish eagle over a carcass (above)—are common on the lakes. The storks usually plunder other predators' food, or eat eggs in nests when they find them, but they'll kill adult flamingos too. Their method: They stab the birds to death with their bayonet bills.

WEBSITE EXCLUSIVE

Get ■ desktop flamingo image, send a friend ■ hot-pink holiday e-greeting, and learn how you can adopt a flamingo in Did You Know? at nationalgeographic.com/ngm/0312.

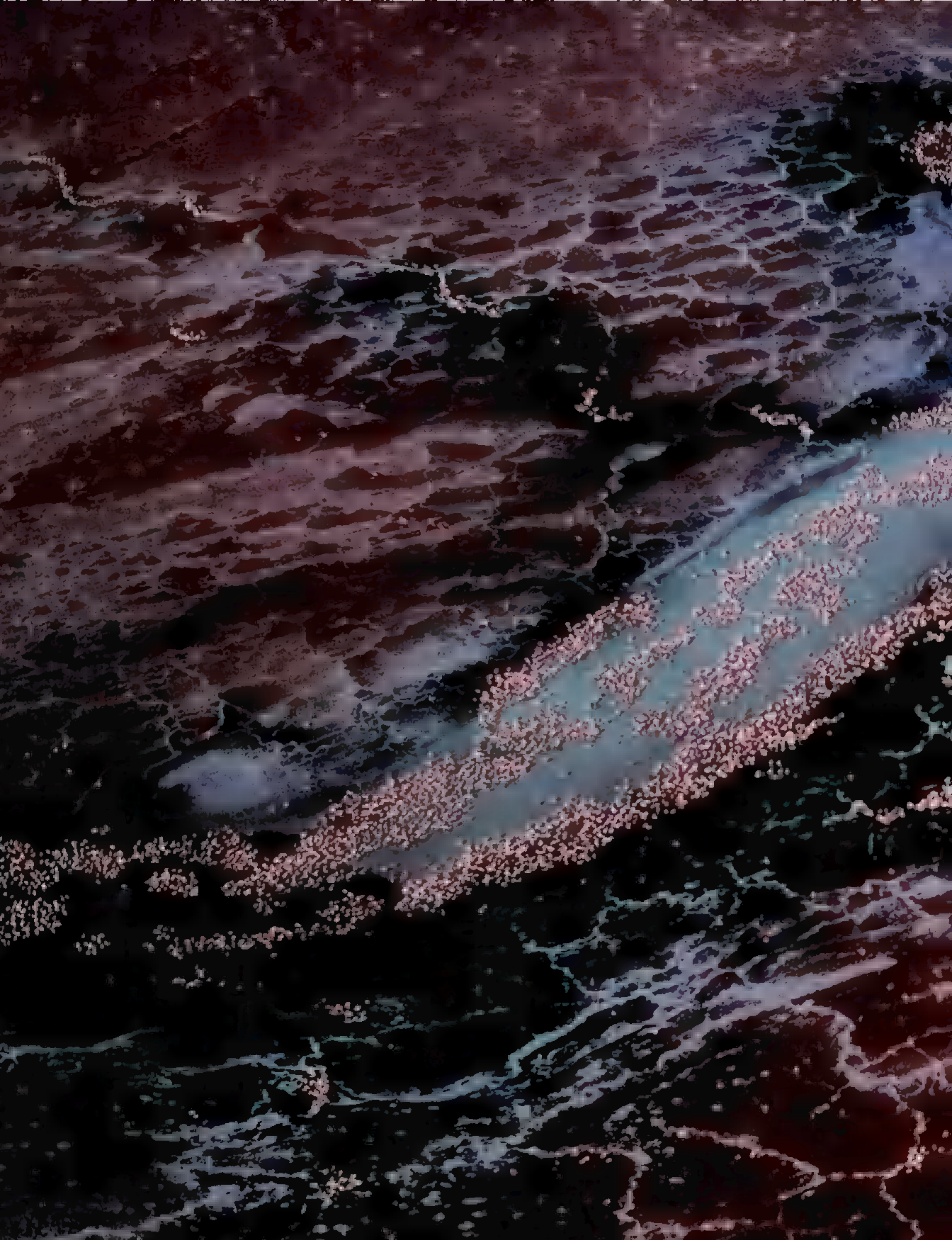


pounce

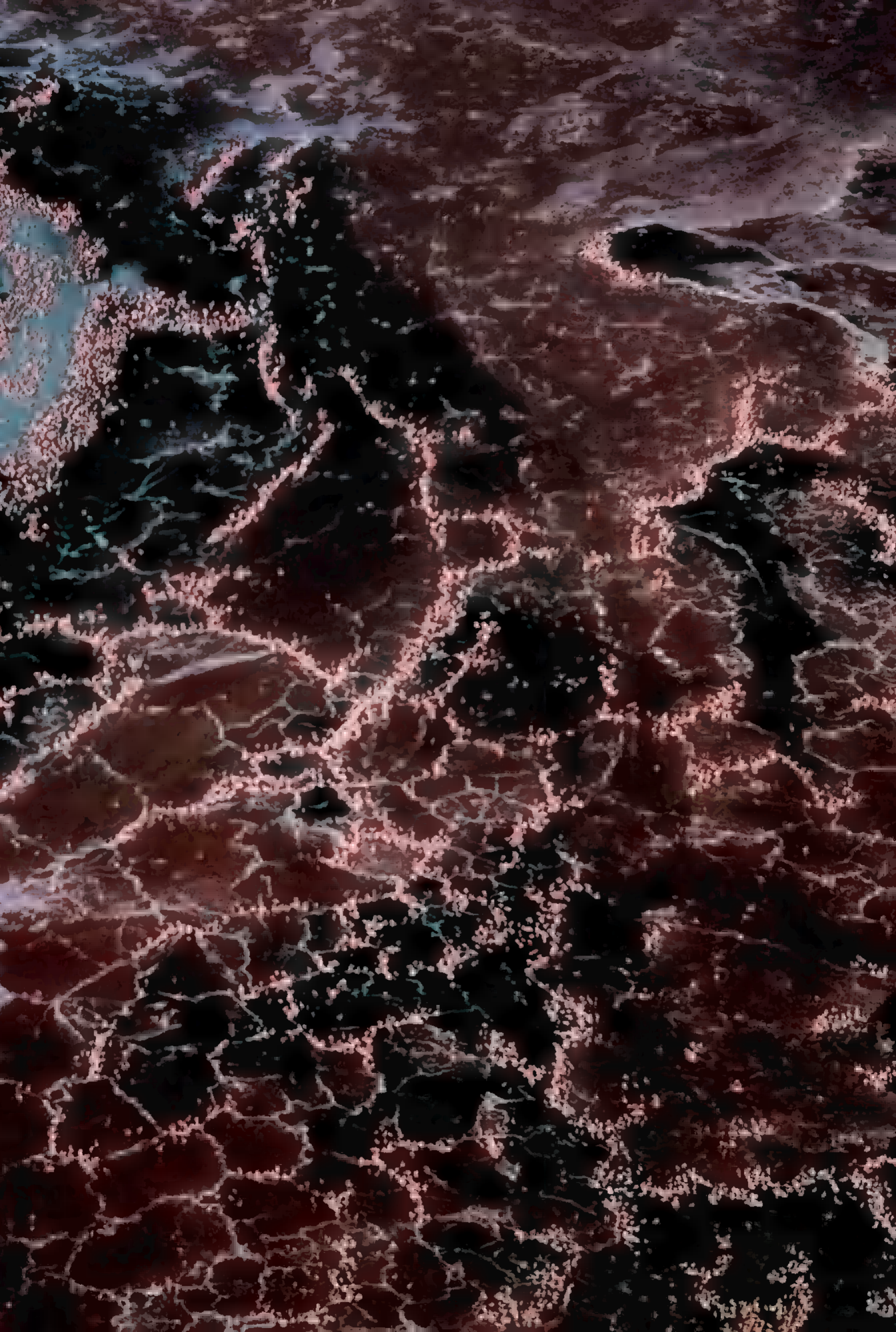
In hot pursuit of pink, ■ golden jackal speeds through the shallows of Lake



Makat, inside Tanzania's Ngorongoro Crater. This day its prey was faster and flew away.



Nesting flamingos spill across mineral-painted Lake Natron in Tanzania—one of the few sites in Africa where the birds regularly lay eggs. Natron's unbearable heat, undrinkable water, and unwalkable mudflats offer safety from most predators. Parents scrape mud nests from the lake floor and tend their single chick together.





liftoff

Lake Nakuru's flamingo population is as ephemeral as a trail of footprints across its



surface. The nomadic birds aren't vanishing. Guided by their needs, they simply move on. □





Weekend samurai tangle at a battle reenactment along the Ara River in Yorii, the site in 1590 of a clash between 50,000 armored warriors. Those soldiers attacked each other with cannon, muskets, swords, lances, and bows and arrows. Four centuries later at this town festival—one of many samurai-themed events held in Japan—the combatants wield lances tipped with foam. “All Japanese grow up playing with swords like samurai,” says a participant. “It was a pleasure to discover I could play again like a kid.”

RICHARD YAMASHITA

JAPAN'S



WAY OF THE WARRIOR

On the battlefield they inspired terror, harvesting heads and glory with their swords. Their leaders wore fierce masks and horned helmets. All lived by a code that valued death over defeat. They were the samurai, the elite warrior class who ruled Japan for nearly 700 years, leaving an indelible mark on a land still making peace with its violent heroes.

BY TOM O'NEILL

NATIONAL GEOGRAPHIC SENIOR WRITER

PHOTOGRAPHS BY

MICHAEL YAMASHITA

IRA BLOCK



A bridge to the past leads to a mist-veiled castle in Matsumoto, one of the best preserved fortresses from the samurai's reign, which stretched from the late 12th to the mid-19th



MOCHIMARU, YAMAMURA, YAMAMURA, AND KUROKI, OSAKA CASTLE, MICHIMONO (1700-1710)

centuries. Rising to power as ruthless soldiers, samurai leaders also fancied themselves as sophisticates, hosting plays, poetry readings, and tea ceremonies in their lofty strongholds.



The swift, sharp justice of a samurai sword propels a kabuki drama at the Hikiyama Festival in Nagahama. Samurai heroes animate many plays written for kabuki, a dramatic form that emerged in



©MICHAEL TAMASHITA

the early 1600s as entertainment for commoners. Scandals involving actresses and their samurai admirers compelled the government to ban females from the kabuki stage, a tradition that holds today.



MAKE WAY FOR THE SAMURAI. EYES DROP, AND CROWDS STEP ASIDE AS A WARRIOR STRIDES HAUGHTILY DOWN A CONGESTED LANE IN EDO, THE FUTURE TOKYO. THE TIME IS THE EARLY 18TH CENTURY, BUT IT COULD BE A HUNDRED YEARS EARLIER OR LATER: THE SCENE WOULD REMAIN THE SAME IN A JAPAN FROZEN IN FEUDAL WAYS. ON THE STREET THERE IS NO MISTAKING A SAMURAI.

Two swords, a long one and a short one, protrude from his waist. As a member of Japan's highest class, that of the warrior, only a samurai may carry both swords, lethal symbols of his authority.

He wears a kimono topped by flowing, skirt-like trousers and a short, loose jacket. His head is shaved on top, with the hair on the sides and back gathered up into a dandyish topknot. The samurai is in no hurry. The government doesn't require him to work, though he might take a job to supplement his yearly stipend of rice. He is asked only to stay in fighting form and to defend the regime in times of trouble. And should some commoner dare to disrespect him—fail to obey an order or bump into his sword—the samurai has the right (rarely invoked) to kill the ingrate on the spot.

Swagger came as a birthright to samurai. Their warrior class dominated Japanese history for nearly 700 years from 1185 to 1867, a reign as ruthless and violent—and as culturally rich—as almost anything experienced in ancient Rome or medieval Europe. Old Europe's knights, in fact, may be the samurai's closest historical kin. Like the knights, samurai (the word means "one who serves") formed a military elite, composed of clan leaders or warlords and the loyal soldiers who fought under them. Traditionally the emperor commanded the highest allegiance in Japan. But as the samurai rose to power, the emperor was relegated to a figurehead, eclipsed by a military dictator called shogun, or commander in chief, a designation that signaled the new rule of the samurai.

The samurai and the knight would have recognized each other in battle. They both wore armor, attacked on horseback, fought with swords and lances, besieged castles, and lived by a code of honor. But where the samurai and the knights differed was in their longevity. The Japanese warrior class enjoyed an amazing run of dominance that ended only when American warships sailed into Japan's harbors, exposing the



inability of the shogun to defend the country. Forces rallied around a new emperor and easily overthrew the shogun's army. The samurai's reign had ended.

THIS YEAR JAPAN IS CELEBRATING with festivals and exhibits the 400th anniversary of the beginning of the Edo period (1603 to 1867), which saw the samurai reach the pinnacle of authority and privilege. Now comes the worldwide release of *The Last Samurai*, a Hollywood blockbuster about the final post-Edo days of the Japanese warrior. So it's true: The samurai still lives. In fact, it's hard to escape him. To walk around any Japanese city or town is to collide regularly with the image of the haughty warrior. His face and his weapons appear on posters for action movies, on billboards warning against drunk driving, on museum banners and comic book covers, in shop windows arrayed with armor, helmets, and swords to announce Children's Day on May 5, a time for families to celebrate the health and vigor—the inner samurai—of their young, particularly boys.

The enduring appeal of the samurai stems from a simple fact: Here is one of the world's greatest action figures, mythologized most often as a lone swordsman who against impossible odds slays dozens of enemies in the name of duty and individual glory. The samurai is the cowboy, the knight, the gladiator, and the *Star Wars* Jedi rolled into one. Who hasn't seen a samurai swing a sword? Initiation may come from viewing *Seven Samurai* or *Throne of Blood*, classic warrior films made by Japanese director Akira Kurosawa, or, on the other end of the gravitas scale, from watching on *Saturday Night Live* the crazed samurai skits of the late comic John Belushi, who wielded his sword like a food processor.

Does the samurai deserve this iconic, leading-man stature? Actually, history demands a rewrite. Instead of the one-dimensional justice-wielding sword slinger of popular culture, the real Japanese warrior was many things. Over the course of seven centuries the samurai underwent a significant transformation, evolving from a courtly duelist to a professional soldier carrying a gun, and finally to a pampered ward of the state.

Off the battlefield the samurai also confounds stereotypes. The same warrior who took trophy heads in combat was likely a worshipful Buddhist. The religion's emphasis on austere self-control appealed to a samurai intent on perfecting his fighting techniques. And as members of Japan's highest class, the samurai, particularly clan leaders and their top generals, indulged in such refined cultural pursuits as flower arranging, composing poetry, attending performances of Noh drama, and hosting tea ceremonies.

Yet for all the attention and prominence given to the samurai, many

Beautiful and deadly, the sword of a high-ranking samurai with its dragon-entwined engraving symbolizes the authority and grandeur of the warrior class. Nearly 400 years old, this 16-inch wakizashi, or short sword, would fetch at least \$170,000 at auction today. Above all their possessions, samurai prized the long and short swords they wore at their waists, lavishing attention even on the sword guard (left).

IRA BLOCK (BOTH)
SWORD: JAPANESE SWORD MUSEUM,
TOKYO; SWORD GUARD: HAYASHIBARA
MUSEUM OF ART, OKAYAMA

CRESTS: AN ILLUSTRATED ENCYCLOPEDIA
OF JAPANESE FAMILY CRESTS,
GRAPHIC: SHA PUBLISHING CO., 2001.

CREST CONSULTANT: YOSHIDA KAMON
ART, LOS ANGELES

CREST (BELOW): MINAMOTO (GENJI)

Japanese adults are uncomfortable with the samurai mythology. The adulation of samurai heroes with their take-no-prisoners fighting spirit was used by 20th-century politicians and military officers to stoke the flames of militant nationalism, triggering Japan's involvement in World War II. With Japan's postwar embrace of pacifism, now even the word samurai may cause unease. "Samurai to many of us implies fighting, killing," Kunio Kadowaki, a photographer's assistant from Kyoto, told me after I confessed to some difficulty in getting people to discuss the samurai. "Some of us like to use another word for warrior, *bushi*, which has a higher, more chivalrous meaning."

To understand modern Japan is to confront the legacy of the samurai, review their vivid role in history, and to figure out just how far beneath the surface the fighting spirit still stirs.

HISTORY FIRST TAKES NOTICE of the samurai in the tenth century, placing them as guards at the imperial court in Kyoto and as members of private militias employed by provincial lords. Efforts by the court to mold a conscript army out of small landowners and peasants had failed. In response, nobles in the capital and wealthy landowners in the outer provinces created their own security forces, which included ambitious young members of the gentry, tutored in the arts of combat. "In essence," says historian Karl Friday, a leading samurai scholar from the University of Georgia, "the first samurai were mercenaries, privately trained and privately equipped."

Over time authority drained from the emperor's seat as powerful samurai clans formed in the countryside. Eventually the two strongest clans, the Taira and Minamoto, fought each other for control of Japan. The Minamoto troops prevailed in 1185, and their leader, Yoritomo, consolidated his power in a new capital in the fishing village of Kamakura in eastern Japan.

I had to look hard to find traces of Yoritomo, the first shogun. Earthquakes, fires, and warfare—not to mention urban development—have erased most architectural traces of medieval Japan. Also, the Japanese as a people are modest worshipers, not prone to erecting monuments to



MICHAEL YAMASHITA (ABOVE), IRA BLOCK, FAMILY CREST, INQUE

With samurai intensity a wiry contestant draws his bow during a kyudo, or archery, competition in Tokyo. A favored weapon of early samurai, the traditional Japanese bow takes shape in the hands and feet of Shibata Kanjuro, a 21st-generation bowmaker in Kyoto (right). Working with 30-year-old bamboo, he applies tension to give the seven-foot-long bow its classic contour.





The fury of samurai warfare with its sword-waving charges and flashing arrows unfolds on an antique screen depicting the fall of Osaka castle in 1615. After forces led by Tokugawa Ieyasu, the reigning



IRA BLOCK UGAKA CASTLE MUSEUM INTD

shogun, or commander in chief, routed the castle defenders, the heads of enemy officers were presented to him as trophies. Muskets had entered Japan more than 70 years earlier, but never deposed the sword.

their historical giants. When I visited Kamakura, now a well-heeled outer suburb of Tokyo, visitors packed the center of town. They had come not to commune with history's ghosts but to photograph cherry blossoms, which had exploded with a tropical profusion of pinks on a warm Sunday in early April. Couples and families drifted with their digital cameras under a tunnel of cherry trees, the brilliant foliage marking the route designed by Yoritomo as an offering to assure that his pregnant wife, Masako, would safely deliver his heir.

Samurai identified with the fragile, transitory beauty of the cherry blossoms. They wrote poems about cherry trees and held extravagant cherry-blossom viewing parties. I couldn't quite picture a hard-faced samurai mooning over nature, but my interpreter, Toko Nagase, explained the connection. "The cherry blossom doesn't cling to the tree until it withers," she said, "but falls in its prime, the same way the samurai imagined himself dying in battle."

WHEN CLAN WARS BROKE OUT in those early medieval days, combatants faced off more like well-mannered rivals than vicious enemies. The early samurai leaders idealized single combat, preferably fought on horseback with a bow and arrow. A warrior seeking a worthy opponent would gallop to the front lines and call out his pedigree and a list of his accomplishments, as recounted, for instance, in one medieval war epic: "Ho, I am Kajiwara Heizo Kagetoki, descended in the fifth generation from Gongoro Kagemasa of Kamakura, renowned warrior of the East Country and match for any thousand men. At the age of sixteen . . . receiving an arrow in my left eye through the helmet, I plucked it forth and with it shot down the marksman who sent it."

Once the breast-pounding was completed, mounted archers let their arrows fly. Then samurai armed with swords and lances charged in. Many times a battle ended abruptly with the death of a general. Even in prolonged fights or sieges, casualties were relatively low, usually fewer than a thousand. As Sir George Sansom, the great chronicler of medieval Japan, pointed out, "Plagues and famines were much more deadly than medieval weapons."

Chivalrous behavior on the battlefield gradually disappeared as samurai armies grew in size and foot soldiers began to outnumber mounted warriors. But some facets of early samurai warfare endured and became classic, if rather gory, traits of the ideal warrior. To avoid the dishonor of capture, defeated samurai began practicing *seppuku*—suicide by disembowelment. It was such a painful ordeal, slicing open one's abdomen and dying slowly, that the samurai modified the ritual and allowed an attendant to behead the warrior as soon as he stabbed himself.

Samurai also sought glory by headhunting. When a battle ended, the

Deerskin chaps complete the medieval hunting outfit worn by participants in a yabusame, or mounted archery, event in Nikko. In this sport, adapted from a samurai training exercise, horsemen moving at full gallop fire arrows at small wooden targets. Samurai cavalry used their iron stirrups to smash foot soldiers in the face—a use spared a lacquered pair (below) made after the samurai wars ended.





MICHAEL YAMASHITA (ABOVE); IRA BLOCK, HAYASHIBARA MUSEUM OF ART, FAMILY CREST, ODA

warrior, true to his mercenary origins, would ceremoniously present trophy heads to a general, who would variously reward him with promotions in rank, gold or silver, or land from the defeated clan. Generals displayed the heads of defeated rivals in public squares.

The lopping off of heads still brings gasps and cheers in the fashionable Ginza neighborhood of Tokyo. One afternoon inside the baroque Kabukiza Theater, an audience watched the samurai hero Gongoro, his face streaked with red paint, pull out a sword the size of a tree limb and with one swing—and a generous dose of stagecraft—slice off the heads of a half dozen enemies, thus restoring the rightful ruler to power.

Such samurai heroics have propelled kabuki plays ever since this theater form with its melodramatic, opera-style poses and emotions emerged in the 17th century as entertainment for the common classes. Today these dramas provide the public with an undimmed view into the soul of the idealized samurai. The plays deal with revenge, honor, conflicts of loyalty, and sacrifice, key elements of a code of ethics known as *Bushido*, or way of the warrior. Kabuki samurai who live up to the code present modern audiences with a warrior the public can live comfortably with—a reluctant hero rather than a soldier of fortune.

How does one get inside the skin, the soul, of a samurai? I posed this question to Danjuro Ichikawa, the actor who played Gongoro in Tokyo. “I push the nuance of knight, rather than soldier,” Ichikawa told me at his home, his voice and eyes as intense in private as on stage. “My performances should bring out the feeling that the warrior has a different sense of life and death than we do, that he will choose death if his honor is questioned. My mission is to show the audience that such a way of life once existed.”

The three major periods of the samurai epoch reflect the rise and fall of specific shogun regimes. Each established its own capital: first Kamakura, then the Muromachi district of Kyoto, and finally Edo (Tokyo).

HEMART



THE REAL-LIFE IMAGE of the honorable warrior probably did not survive much beyond the Mongol Wars, a brutal wake-up call to the samurai about the nature of battle. Twice in the late 13th century, large Mongol forces under the command of Kublai Khan, grandson of the Asian conqueror Genghis Khan, attacked Japan from the sea. The samurai fought back on beaches and from boats. Both times ferocious storms came to their rescue, with high winds and seas crippling the Mongol fleets. The samurai called the second typhoon the *kamikaze*, or divine wind, a name adopted by Japanese suicide pilots during World War II.

The savage hand-to-hand combat the samurai found themselves locked into with Kublai Khan's troops ended reliance on the bow and arrow as the best way to kill and elevated the sword as the preferred weapon. The rise of the sword coincided, in turn, with the downfall of the Kamakura shogunate and the rise of a new regime under the Ashikaga clan. Increasingly wars were fought not only on open plains suitable to cavalry charges but also in mountainous terrain, the domain of upstart warlords, where samurai were forced to fight on foot. It was now slash or be slashed.

Michihiro Tanobe, chief curator at the Japanese Sword Museum in Tokyo, was reluctant to let me touch, much less lift, a 600-year-old samurai sword valued at ten million yen, or about \$85,000. Instead, he gingerly placed the gleaming razor-sharp steel sword, more than two feet long, in my lap. This was a *katana*, the



ONLY SAMURAI, THE HIGHEST CLASS, COULD CARRY TWO SWORDS.



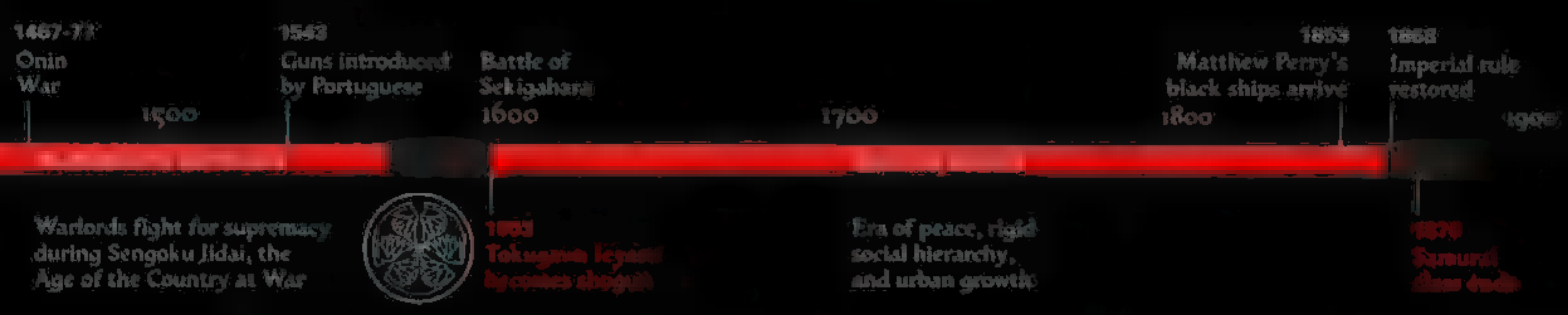
FARMERS GAVE AS MUCH AS 50 PER CENT OF THEIR RICE CROP TO SAMURAI.



ARTISANS SUPPLIED CLOTH (ABOVE), SWORDS, ARMOR, AND SAKE.



CONSIDERED PARASITES BY SAMURAI, MERCHANTS OCCUPIED THE LOWEST RUNG.



WHEN WARRIORS RULED JAPAN

From modest beginnings as militiamen and imperial court guards, the samurai seized power in 1185, installing themselves as a privileged ruling class, their authority based nakedly on force. Numbering about 6 percent of the population, samurai (the word means "one who serves") thrived in a feudal society in which they pledged loyalty to a warlord who needed soldiers to protect and expand his fiefdom. With the emperor reduced to a figurehead, the shogun held ultimate sway as a military dictator, though frequent clan wars undermined his power.

As the nature of warfare changed, so did the samurai. They began as chivalrous warriors on horseback, challenging opponents to ritualized archery battles. But as rivalries grew between clans, and armies became larger and fighting more savage, most samurai served as foot soldiers trained for hand-to-hand combat.

In their final guise during the 250-year-long peace of the Tokugawa shoguns, many samurai became idle aristocrats, installed at the top

of a rigid four-tiered class system (below left). Their military skills waned, merchants eclipsed them in wealth, and in the late 1860s forces loyal to the emperor, including disgruntled samurai, overthrew the once indomitable warrior class.

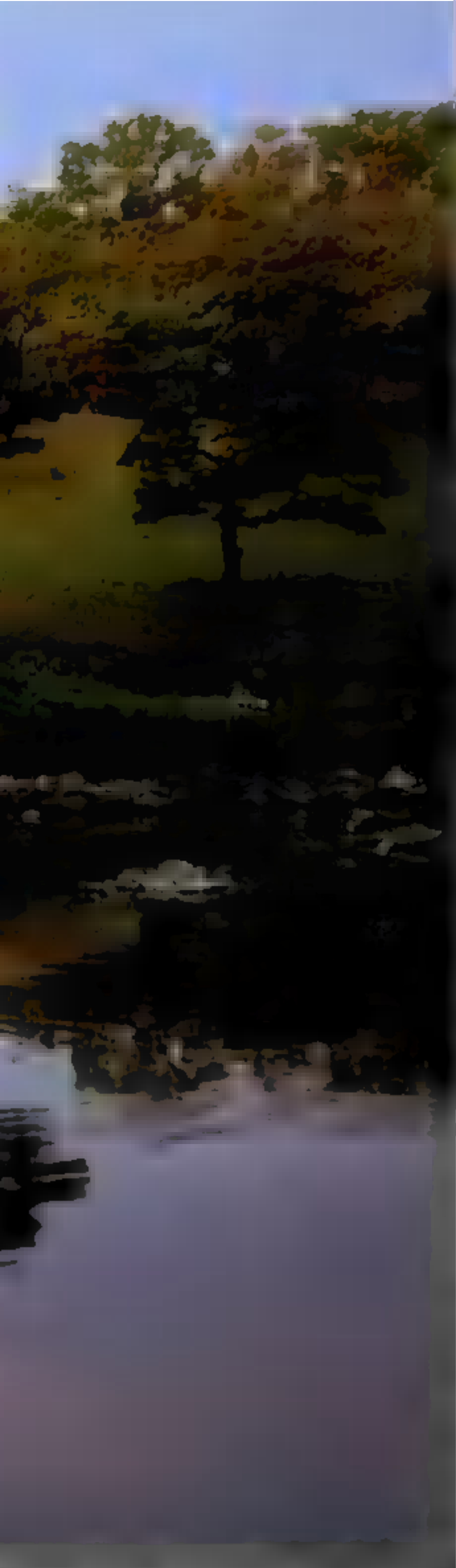




samurai's trademark battlefield sword. The samurai also wore a shorter blade, the *wakizashi*, more of an indoor weapon. Both types were on view in the exhibit, arrayed on pedestals like jeweled crowns. The identifying marks of a classic Japanese sword are its curve—like the arc of a new moon—and the often wavy border called the *hamon*, which divides the hard steel on the edge and the softer steel of the sword's body. Experts consider the katana the finest fighting blade ever made.

The ancient craft of Japanese swordmaking almost disappeared after World War II, when the Allies confiscated and destroyed an estimated five million swords and banned the manufacture of new ones. American soldiers feared the sword, or more accurately, its mystique, Tanobe explained, "because Japanese soldiers would make these *banzai* attacks"—desperate all-out charges—"holding their sword as if they believed in its magical powers." The Japanese managed to hide many of the top-quality blades, and in 1953 the prohibition against owning a sword was lifted. The craft revived, driven by rich collectors, and today artisans make swords a warlord would have been proud to carry into battle.

On a garden-lined street in a northeastern suburb of Tokyo, the muffled beat of a hammer pounding on steel alerts neighbors that



swordsmith Yoshindo Yoshihara is hard at work. A tenth-generation *katanakaji*, or maker of the long sword, Yoshihara labors inside a backyard shed, a dim, tool-lined space lit by the glowing heat of a forge. The day I visited, Yoshihara had reached the midpoint of turning raw steel into a polished sword, a process that takes from two to three weeks. A professorial-looking man with wire-rimmed glasses and goatee, Yoshihara knelt on a straw mat and began to work with a narrow baton-size bar of steel. Working the bellows of the forge with one hand, he used the other to thrust the bar into a bed of blazing coals. As soon as the bar turned yellow-hot, Yoshihara pulled it from the fire pit and with a metronome's steady beat began hammering and thinning the heated metal, drawing out the curve and width of a blade. He worked the steel as if it were modeling clay.

Taking a break, Yoshihara led me into a finishing room where several apprentices were polishing swords. Yoshihara handed me one which I gripped with both hands, its heft like that of a heavy baseball bat. As I began to compliment its shape and its wavy hamon, Yoshihara held up a hand. "Remember, a sword is a weapon first of all. If it is not sharp and can't cut, it is not beautiful."

Collectors will pay up to \$35,000 for a newly made samurai sword not only, Yoshihara believes, because it is an art object but also because it represents "a remnant of the samurai spirit, to protect family and home."

THE SWORD'S DOUBLE IDENTITY as weapon and art object mirrors the split consciousness of the long-ago samurai leaders, many of whom fancied themselves as both warrior and aesthete. At their castles, the *daimyo*, or great names, as the samurai land barons were known, held regular salon-like gatherings for painters, playwrights, and intellectuals. They attended—even took part in—private performances of Noh drama, a solemn and stylized theater form for the elite. Samurai generals practiced calligraphy, took up flower arranging, and

A miniature Mount Fuji rises in Suizenji Garden, a 17th-century warlord's re-creation of the scenery between his castle in Kumamoto and the capital in Edo. The shogun controlled the warlords by forcing them to travel often to Edo, where he kept their wives hostage. The Nakasendo, a mountain road, passed through Tsunomago (right), which preserves its Edo-period street front.



MICHAEL YAMASHITA (BOTH); FAMILY CREST, HONDA



A forbidden pleasure for samurai, geisha dancing with its silken sweep of kimonos still graces the stage of the Gion Kobu Kaburenjo theater in Kyoto. Such entertainments, part of the emerging urban culture



MICHAEL YAMASHITA

in Edo-period Japan, conflicted with the sober tastes of the shogun. Many samurai, however, couldn't resist the excitement and eagerly attended performances, often in disguise.



played the lute. During the savage Onin War (1467-77), when much of Kyoto burned to the ground, officers entertained themselves between battles by composing poems and dressing up in flamboyant silk costumes.

Of all the high-ranking samurai's cultural pursuits, none infatuated them as much as the tea ceremony. By the 13th century Zen Buddhist monks had introduced the rituals of tea drinking to the Ashikaga warlords, who practiced it on a lavish scale. Yoshimasa, the eighth Ashikaga shogun, promoted a simpler, more spiritual ceremony in the late 1400s. At his ornate villa outside Kyoto, Yoshimasa added a small tea room that held only a handful of people, the model for today's ceremonies. Powerful warlords began to follow his example by adopting the tea ceremony as a badge of refinement. The meditative act of making and drinking tea in a small space—one where sword wearing, even by samurai, was forbidden—must have captivated battle-weary warriors. Some samurai prized their tea utensils as much as their swords. The hard and soft edges of the samurai show up in a description of the general Kanamori Yoshishige: "He defended the castle of Kishiwada and personally took 208 heads. He was also a noted tea master."

Inside a serene first-floor room in an office building in downtown Osaka, where sunlight crept through rice-paper windows, I bowed to tea master Chikuyu Fukuda and asked him about the link between the warrior and the tea ceremony. Master Fukuda had just finished conducting a practice ceremony for a few students. I had joined them in drinking frothy green Chinese tea, made from a powder that Fukuda had prepared with a whisk and hot water. After sipping the tea from the same 500-year-old cup, we took several minutes to admire the carefully orchestrated grace notes of the room—the sprig of pear blossoms flowing from a vase, the smell of plum wood incense.

"The tea ceremony is a spiritual activity," Master Fukuda told me,

Shaved eyebrows, blackened teeth, and an oval face defined female beauty during the samurai era, a look found on masks used in Noh theater, the classical drama form once reserved for the elite. Samurai of all ranks played go, a board game about territorial conquest, doubtless as addictive as the cell-phone video games of young kabuki actors (above).

MICHAEL YAMASHITA (ABOVE); IRA BLOCK, HAYASHIBARA MUSEUM OF ART
CREST: TAIRA (HEIKE)



sitting on his heels in the formal way. He looked about 60, had a thin, handsome face, and wore the broad *hakama* trousers typical of the samurai. "The samurai came to a tea room to calm down and appreciate the moment," he said. I admitted that I couldn't picture a samurai squeezing his ego into such a delicate space and letting down his guard. The tea master smiled and suggested that I, like the warriors of old, should relax, look around the room again, and enjoy myself. So I did. The sense of well-being I experienced was perhaps the closest I came to appreciating how a medieval samurai might have felt during a rare recess from war.

NO AMOUNT OF CULTURAL REFINEMENT or religious observance could quell the deeper instincts of most samurai leaders for naked power. The unchecked ambitions of the warlords ran amok during the Ashikaga shoguns' reign—a period of frequent warfare from the early 1300s to the late 1500s—akin to the darkest days of medieval Europe. Any semblance of central rule had dissolved entirely by the mid-15th century as the most powerful clans (about 20 controlled most of Japan) fought for supremacy during a 100-year period called Sengoku Jidai, the Age of the Country at War.

The character of battles changed dramatically. Armies of tens of thousands of samurai marched across the land to lay siege to castles, their ranks swollen by the enlistment of farmers pressed into battle as foot soldiers. Many of these *ashigaru*, or light feet, carried firearms. Muskets called *harquebuses* arrived in Japan in 1543, carried by Portuguese adventurers blown off course on a voyage to China. Japan quickly copied the technology, and within 30 years its armies led the world in the number of guns shouldered into combat. Battles became longer, bloodier, and more decisive. With each defeat of a warlord the countryside was flooded with his surviving unemployed warriors, the masterless samurai known as *ronin*, men of the waves.

Those combat-mad times—and the hundreds of films, video games, comic books, and TV dramas they still spawn—feed the imaginations of those Japanese children who grow up playing with plastic swords. Most outgrow the samurai fantasy, but a battleground exists for those who don't, those who crave the sensation well into adulthood of strapping on armor, unsheathing a sword, and playing war.

Each spring in cities and towns across Japan, make-believe samurai clash in battle reenactments. The events involve hundreds of local citizens—from businessmen and rice farmers to high school students and teachers—who parade down streets in resplendent rented armor. Afterward, usually on an open field or in a park, the weekend warriors act out a highly choreographed, noncontact version of a famous battle, often to stormy music played over a loudspeaker.

To some history buffs, these civic extravaganzas have sissified the

Recalling a form of begging adopted by masterless samurai called ronin, members of the Komuso Society walk in Tokyo playing bamboo flutes with their faces hidden. Ronin collected alms this way during the peaceful Edo period, wandering the countryside as humble monks. Without war, many samurai turned to martial arts like kendo, sword fighting often practiced with bamboo staves (below).





MICHAEL YAMASHITA (BOTH); FAMILY CREST, MIYAKE

samurai, elevating spectacle over realism and, worse yet, taking away the fun of fighting. One Friday in mid-April on a wide bank of the Ara River, outside the town of Yorii, I met a band of maverick reenactors who were determined to add grit and bruises to the pageantry. Practicing for the next day's battle—the re-creation of the siege of Hachigata castle in 1590—they had strapped on glossy red or black armor that from a distance made them look like giant, hyperactive beetles. Even in dress rehearsal they were fighting. They jabbed each other with foam-tipped lances, weapons customized by the organizers so combatants could strike each other without too much damage.

Their ranks included a construction worker, a physician, a graduate student in history, a former movie stuntman, a warehouse employee, a novelist, and a salaryman—a Japanese office worker. “I love armor,” said salaryman Kimiya Kimura, preening in his hard, shiny shell. “Would you want to go back in time?” I asked. “Hmm, fifty-fifty,” he replied. “I romanticize those times, but I also fear them. It was live or die.”

On the day of the battle, the hard-core samurai skipped the town parade with its large contingent of nonfighting warriors and instead took their places in rival squads facing off across the river at the site of the original confrontation. They barely glanced at the curious spectators, made up of a scattering of post-parade townspeople and tourists who settled on rocks and ate rice balls and chocolate-covered bananas as war drums pounded and a cannon boomed. The combatants looked fierce and realistic—except for the plastic goggles, worn to prevent eye injuries. The action would go by the history book, with a few amendments. A one-month siege was being compressed to 40 minutes of combat, and instead of 50,000 soldiers, there were 100.



Enjoying an energetic history lesson, townsfolk (and sometimes women) with bamboo lances and plastic swords charge across a soccer field in Yonezawa as they reenact one of Japan's bloodiest conflicts, the 1561



RICHARD YAMASHITA

battle of Kawanakajima. Festival fighting consists mostly of gentle shoring as bombastic music plays and a commentator describes the action. In the actual battle at least 17,000 were killed or wounded.



A blast on a conch shell launched the fighting. The Toyotomi soldiers crossed the river in two boats and attacked the Hojo forces. On the riverbank the two sides went at it with the gusto of playground pick-up teams. If a samurai was stabbed, he had to fall and count to ten before rising from the dead. Back and forth over the river went the indestructible samurai. At the 35-minute mark, the wrong side, the Hojo, was winning, necessitating a time-out for the battle coordinator to remind the fighters of historical accuracy. Finally, just as a heavy rain began to fall, the Toyotomi forces vanquished the Hojo. The audience fled for cover, missing the chance to see the antagonists high-five each other, having lived to see another reenactment.

That long-ago battle from 1590 belonged to one of the last large military campaigns conducted by the samurai. Over the next 13 years the strongest shogun ever, Tokugawa Ieyasu, would rise to power and force peace on all the warlords. Before Ieyasu, two other great samurai generals from the period—Oda Nobunaga and Toyotomi Hideyoshi—attempted to unify Japan. Assassination by a vengeful general stopped Nobunaga, and two failed invasions of the Korean peninsula weakened Hideyoshi.

Hideyoshi's death from natural causes in 1598 provoked the most



famous of all samurai battles. It pitted the Western Army, recruited by warlords loyal to Hideyoshi's heir, against the Eastern Army, led by Tokugawa Ieyasu, a 58-year-old general who had fought under both Nobunaga and Hideyoshi. The two huge samurai armies, each numbering about 80,000 men, met on October 21, 1600, near the village of Sekigahara in central Japan.

As every Japanese schoolchild knows, Ieyasu and the Eastern Army won in a rout. They used the ancient tactic of treachery. A Western Army general had secretly switched sides and attacked his former allies from the rear, delivering a fatal blow to their defenses. Today a plinth marks the spot where the victorious generals presented Ieyasu with thousands of enemy heads. Three years later Ieyasu took the title of shogun, the first of 15 for the Tokugawa dynasty, and by his death in 1616, he had eliminated all remaining rivals, bringing an end to civil war.

A SAMURAI WITHOUT WAR is like a bird without sky. Gone were the swashbuckling days of battlefield glory and mercenary rewards; violent talents were no longer needed. Ieyasu and his successors had installed such a dominating, autocratic central government that no warlord clan could mount a challenge to it. During the extraordinary 250-year-long reign of peace that resulted, many samurai became idle, state-subsidized aristocrats, the power without the glory.

The Tokugawa regime enforced this lengthy peace through social engineering. The government, now based in Edo, anesthetized ambition by dividing the population into four hereditary classes—samurai, farmer, craftsman, and merchant—and froze them in place. Laws dictated the behavior of each class, defining where they could live, what they could wear, how they could earn money, and what weapons, if any, they could possess. Numbering about two million, some 6 percent of the population, the samurai class took the top rung.

In return for agreeing to defend the shogun government in rare times

A samurai look endures in Kyoto, where fire department trainees in warrior-like headgear practice their skills. During peacetime, samurai pitched in as firefighters and took jobs as police, their legendary bravery and discipline putting them in demand. Today becoming a samurai costs just a hundred dollars for rented gear and the courage to appear in public (right).



MICHAEL YAMASHITA (BOTH). FAMILY CREST: HOJO

of trouble, the samurai received an annual pension of rice, measured in units called *koku* and paid for by an onerous tax, as high as 60 percent, on a farmer's harvest. In the past many samurai had worked as farmers, putting on the armor and sword only when needed. Now most of them lived in castle towns, with nothing expected of them except to keep their blades sharp and to lead upright lives—to stay away from what were considered decadent low-class entertainments like kabuki plays, geisha dances, and anything else patronized by merchants.

But while their blades may have stayed sharp, their fighting skills began to atrophy. Alarmed at the notion of soft samurai, certain teachers drew up codes of behavior to inspire idle sword wearers to retain physical and mental strength. These early self-help manuals gave instruction in sword handling, grooming, how to speak to superiors and inferiors, and how to retain the warrior's edge.

Bushido, the warrior's code, elevated the teaching of martial arts in Edo Japan, a tradition that permeates Japanese society to this day. Millions of Japanese schoolchildren still practice classic warrior skills of sword fighting (*kendo*), archery (*kyudo*), and hand-to-hand, unarmed combat (*jujitsu*) as part of their physical education curriculum. Adults, too, follow the warrior's way. At the Nippon Budokan, a martial arts center near Tokyo's Imperial Palace, I watched kendo students ferociously attack each other with bamboo staves. "Men!" an attacker would shout when a blow struck his opponent's face. "Tsuki!" rang out for a successful strike at the throat.

Breathing hard after practicing sword thrusts with a real blade, Terukuni Uki, the *sensei*, or teacher, sat down to remove his face mask and armor. When I asked him about the modern significance of kendo, Uki answered like a Bushido advocate from three centuries ago, complaining about how the Japanese youth were losing their toughness and their tradition. "Here we teach the spirit of winning, but it's not so much defeating an opponent as overcoming one's own self," Uki said. "These days it seems everyone is looking for someone to blame rather than focusing on himself. We're told to believe that unless you graduate from the best university and are somehow elite, you're a loser. Our message here is that if you try hard, at kendo or anything else, you will enjoy life."

A few of the students stood nearby, listening to the sensei's words. One spoke up: "With kendo you're never frightened, never panicked." He sounded as though he walked the congested streets in Tokyo with an invisible sword hanging from his belt.

ONE OPPONENT the Edo-period samurai were not trained to fight was poverty. A steady rise in the cost of living eroded the value of their rice stipend, which most samurai converted into cash, and slowly the despised merchant class began to eclipse the samurai in wealth and power. "Most daimyo families at the end were bankrupt or close to it," Tsunenari Tokugawa told me. The 18th head of the Tokugawa family, a retired shipping company executive, smiled ruefully as he discussed the dire straits of the samurai with me in his Tokyo office. "A big daimyo with 1.2 million *koku* of rice was once one of the richest men in Japan," Tokugawa said. "But suddenly by the 1800s his revenues from selling his rice couldn't even come close to the earnings of a single kimono store in Tokyo."





MICHAEL YAMASHITA FAMILY CREST: TOKUGAWA

To die like a cherry blossom, which falls at the peak of its beauty (above), held deep appeal for samurai. Warriors facing defeat would rather commit suicide than grow old with dishonor. As an 18th-century manual stated, "A samurai who is not prepared to die at any moment will inevitably die an unbecoming death."

Many newly impoverished samurai took jobs as bureaucrats, martial arts teachers, policemen, and accountants. To bring in needed extra cash, they made items like umbrellas, birdcages, or furniture on the side. The shocking specter of a samurai grubbing for a living appeared in a recent prize-winning Japanese film, *The Twilight Samurai*. Its director, Yoji Yamada, said he was tired of film studio exaggerations of the samurai hero. "I wanted to show that samurai at the end suffered very much," Yamada told me at his Ginza office. "Some couldn't even eat. My main character had to sell his sword to pay for his wife's funeral."

The Tokugawa regime fell abruptly, a collapse as sudden and surprising—and nearly as bloodless—as the fall of the Soviet Union in our time. The trigger was the arrival in 1853, and again seven months later, of the black ships, a small fleet of United States warships led by Commodore Matthew Perry. The appearance of foreign ships pierced the bubble of isolation that had enclosed Japan since the 1630s. Confronted by the military strength of the arriving ships, the shogun dissolved Japan's exclusion policy and began making trade pacts with other nations. This perceived act of weakness sparked revolts by several powerful clans of anti-foreigner—and anti-Tokugawa—samurai.

Acting in the long-dormant name of the emperor, the rebel warriors, backed by influential merchants and farmers dissatisfied with the stagnant shogun government, went head-to-head with the shogun's forces in the late 1860s and swept the Tokugawa regime from power. That the shogun's armies didn't put up much of a fight became clear to me when Yoshihiko Sasama, author and illustrator of comprehensive volumes on samurai armor, unrolled a scroll depicting one of the final battles. Uniformed, well-trained troops loyal to the emperor, armed with rifles from England and France, are shown repelling an almost comical attack on Kyoto by the Tokugawa samurai, many of them waving swords and muskets. "Can you believe it?" Sasama exclaimed. "Half the Tokugawa army is still wearing old-style armor!"

The new Meiji government, named for the young emperor and composed of many educated samurai, pulled Japan into the modern era. Surprisingly progressive, the Meiji rulers soon abolished the class system, broke up the feudal estates, confiscated castles, ended the payment of pensions, and forbade samurai to wear swords. Many of the samurai who helped propel the emperor to power felt betrayed, having believed that he would reinstate a conservative warrior-based rule. In a series of revolts in the 1870s, the Meiji government's well-armed forces overwhelmed the disgruntled samurai, some of whom committed seppuku rather than surrender. The samurai had made their last stand.

NOWADAYS THE SAMURAI SPIRIT still makes headlong charges through the Japanese psyche. The legendary bravery of the medieval warriors stiffens the backbone of public figures who long for a militarily strong Japan. Recently a general prefaced his remarks about meeting the challenge of a threat by North Korea by saying, "We are the descendants of samurai." And though the Japanese constitution prohibits the use of military force in international disputes, and public opinion strongly supports a pacifistic foreign policy, conservative politicians increasingly channel the samurai spirit as they argue for amendments that would allow Japan to fight foreign wars.

Nostalgia for the idealized samurai is undying, cropping up in places such as Tokyo's Sengakuji Temple. Visitors come daily to burn incense on the graves of the 47 Ronin—who in 1703 famously flouted the shogun's power by beheading the official responsible for their master's death. Later the ronin committed seppuku, becoming Japan's most beloved rebels.

And what salaryman locked into a conforming job doesn't dream of being called a samurai, the workplace jargon for the rare person who risks being fired for standing up and speaking his mind?

But for most Japanese, the samurai rests in peace, a violent figure embalmed in history, the tragic hero who emerges now mostly to star in crackling good plots for kabuki plays and action movies. The samurai's time came and went, like a fallen cherry blossom. There's no better epitaph than the opening lines of the *Heike monogatari*, a 13th-century samurai war tale:

"The proud ones do not last forever, but are like the dream of a spring night. Even the mighty will perish, just like dust before the wind." □

WEBSITE EXCLUSIVE

See photos of 19th-century samurai, and learn about women of the samurai class and Christian samurai in Did You Know? at nationalgeographic.com/ngm/0312.



The power of the samurai that emerged in the 12th century with the shogun Minamoto Yoritomo (above) carried Japan through its medieval period and into the modern era. By wearing sword and armor (right), Japanese reenactors connect with the most vivid chapter of their history, when warriors had their way.

MICHAEL YAMASHITA (RIGHT), IRA BLOCK, JINGOJI TEMPLE, KYOTO
FAMILY CREST: UESUGI

宇佐美駿河



WICHITA, KANSAS



4:30 A.M. ARRIVES AT WORK



4:35 A.M. CLEARS SECURITY

67210

Beulah's Boeing

BY CLIFF TARPY PHOTOGRAPHS BY IRA BLOCK
NATIONAL GEOGRAPHIC SENIOR WRITER



5 A.M. PUTS ON COVERS



8:40 A.M. CLEANS "EYEBROW" WINDOWS OF BOEING 737 AIRLINER



9:15 A.M. PREPARES WINDSHIELD FOR SEALING



11:30 A.M. KISSES SON AND FELLOW EMPLOYEE RANDY CHAPMAN



12:15 P.M. RECEIVES PARTS FROM DISPATCHER ANN SPURGEON



4:00 A.M.: STORES BELONGINGS IN LOCKER



4:55 A.M.: SCANS JOB ORDERS



5:00 A.M.: PUTS ON GLOVES



8 A.M.: FUELS UP WITH CO-WORKER JANICE HIGBEE



9:30 A.M.: TAPES WINDSHIELD EDGES



10 A.M.: APPLIES SEALANT TO WINDOW



1:30 P.M.: HELPS MIKE SHOCK WITH HIS BIRTHDAY CAKE



3:30 P.M.: LEAVES PARKING LOT AND HEADS HOME

manufacturers, Wichita turns out half the globe's nonmilitary aircraft, bolstering its claim to be the Air Capital of the World.

At 5 a.m. Beulah Barnes clocks in at a huge, brightly lit aircraft plant. She adjusts the earphones of a portable radio she carries inside her white coveralls, a shield against the deafening chatter of rivet guns fired by workers assembling fuselages of Boeing 737s that sit side by side like colossal metallic sausages.

Most of the workers, including those atop “rainbow tools”—mini-escalators that arc over the five plane bodies—wear earplugs against the din. Beulah’s defense is country music. “When they start shooting,” she says, “I just turn up the volume.”

The music plays all day, and then some: Recent layoffs at the plant mean that survivors like Beulah typically work a ten-hour day or longer. To remind her of home, Beulah tapes snapshots of relatives and her Yorkshire terrier to her toolbox.

A 29-year Boeing veteran, Beulah is part of an honored tradition that began in World War II with squadrons of female factory workers, celebrated in the popular song “Rosie the Riveter,” a mythical figure on posters selling war bonds and boosting morale. Peering through goggles below her platinum hair, Beulah holds a gun different from those used by her riveting colleagues as she runs a bead of black sealant around a windshield. With that, another 737—Boeing’s best-selling plane—moves closer to flight.

Aviation dominates zip code 67210, where Boeing’s 238 buildings sprawl over 1,200 acres, and it propels Wichita’s economy. Boeing-Wichita is part of the world’s largest aerospace firm, which produces about half of all commercial airliners worldwide. Workers at Wichita’s three other major aircraft manufacturing companies produce more than 60 percent of the world’s general aviation aircraft.

Why Wichita sprouted so many wings is part geography, part luck. In the early 1920s the city attracted risk-taking businessmen flush with cash from a flourishing Kansas oil industry and eager to make airplanes. As war loomed in the following decade, “Kansas lobbied very aggressively for defense plants,” says Craig Miner, a Wichita State University history professor. “The very day after Pearl Harbor, the state’s congressmen and members of an industrial development commission phoned the War Department, saying ‘See? The coasts are not safe.’” And at a time when most every Asian face was suspect, Kansas had few Japanese residents.

Boeing-Wichita’s aviation employment exploded from fewer than 800 in mid-1940 to a wartime peak of 30,000. With so many men in uniform, women took up the slack on the assembly line. The song “Rosie the Riveter” hailed the woman who “keeps a sharp lookout for sabotage, sitting up there on the fuselage.”

Rosie the Riveters helped Boeing-Wichita produce a stalwart of World War II, the B-29 bomber, known as the Superfortress. (Two of the craft

“Kansas lobbied very aggressively for defense plants. The very day after Pearl Harbor, the state’s congressmen . . . phoned the War Department, saying ‘See? The coasts are not safe.’”

—CRAIG MINER, HISTORIAN



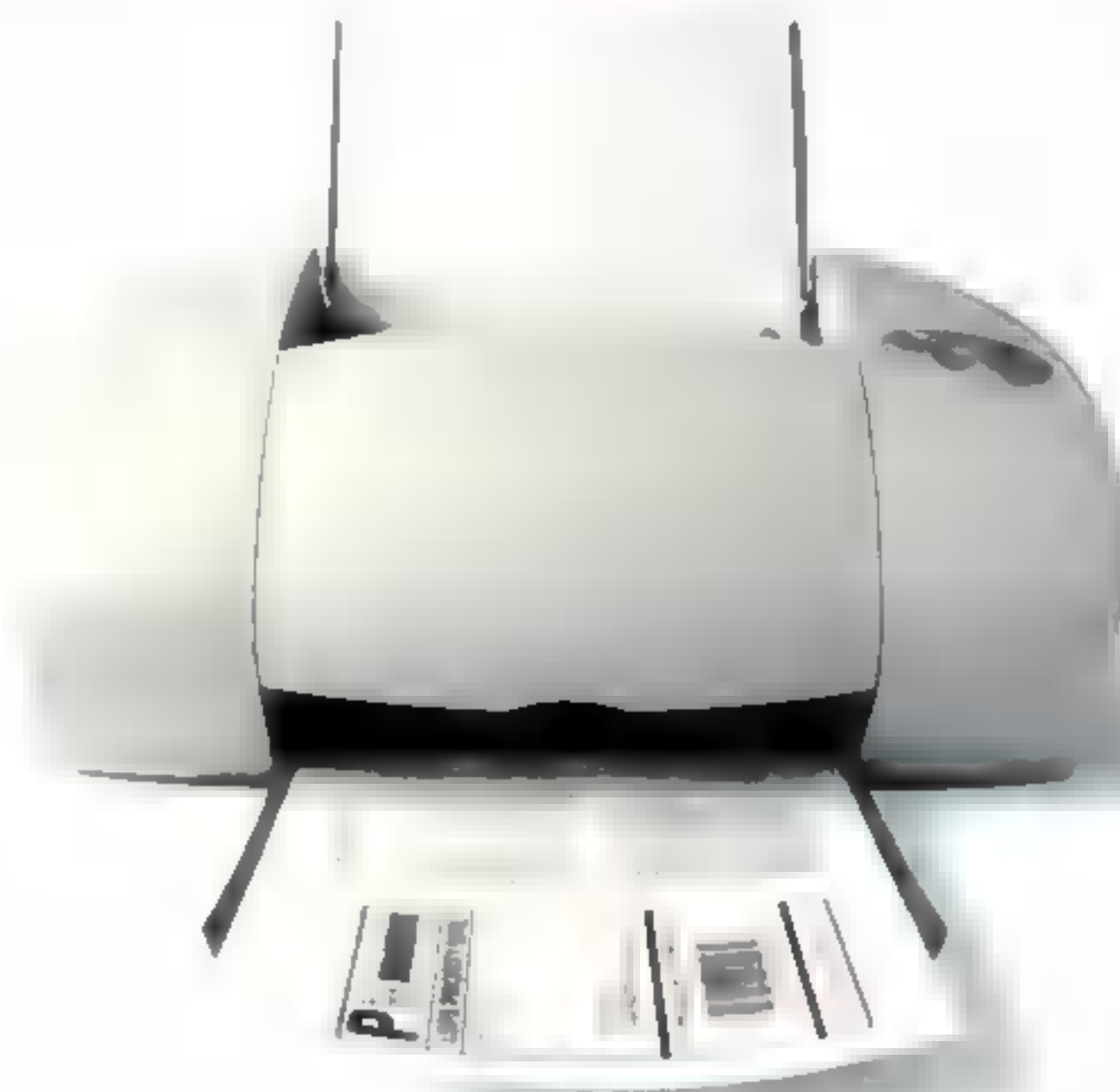
67210

POPULATION: 11,203
AVIATION EMPLOYEES: 12,500
WICHITA POP: 350,000
AVIATION EMPLOYEES, WICHITA: 32,200
MAJOR AIRCRAFT COMPANIES, WICHITA: Boeing, Cessna, Raytheon (Beech), Bombardier (Learjet)
TOTAL AVIATION-RELATED FIRMS: 150

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HO.



HO.



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WICHITA, KANSAS

made elsewhere, *Enola Gay* and *Bockscar*, dropped the atomic bombs on Hiroshima and Nagasaki, forcing Japan to surrender.) Only one B-29 still flies. Named *Fifi*, it follows the air-show circuit from its home base in Midland, Texas. Another, nicknamed *Doc* after the *Snow White* character painted on its nose, may soon join it. *Doc*, one of 1,644 B-29s turned out by Wichita, was lucky, surviving a lowly postwar career as a target for bombing practice. An airline executive found *Doc* mothballed in the California desert and trucked it to Wichita, where restoration is underway. He may make it a flying exhibit with Wichita as its home base—the ardent hope of locals working to restore the plane.

“We wore overalls, and bandannas to keep our hair from getting

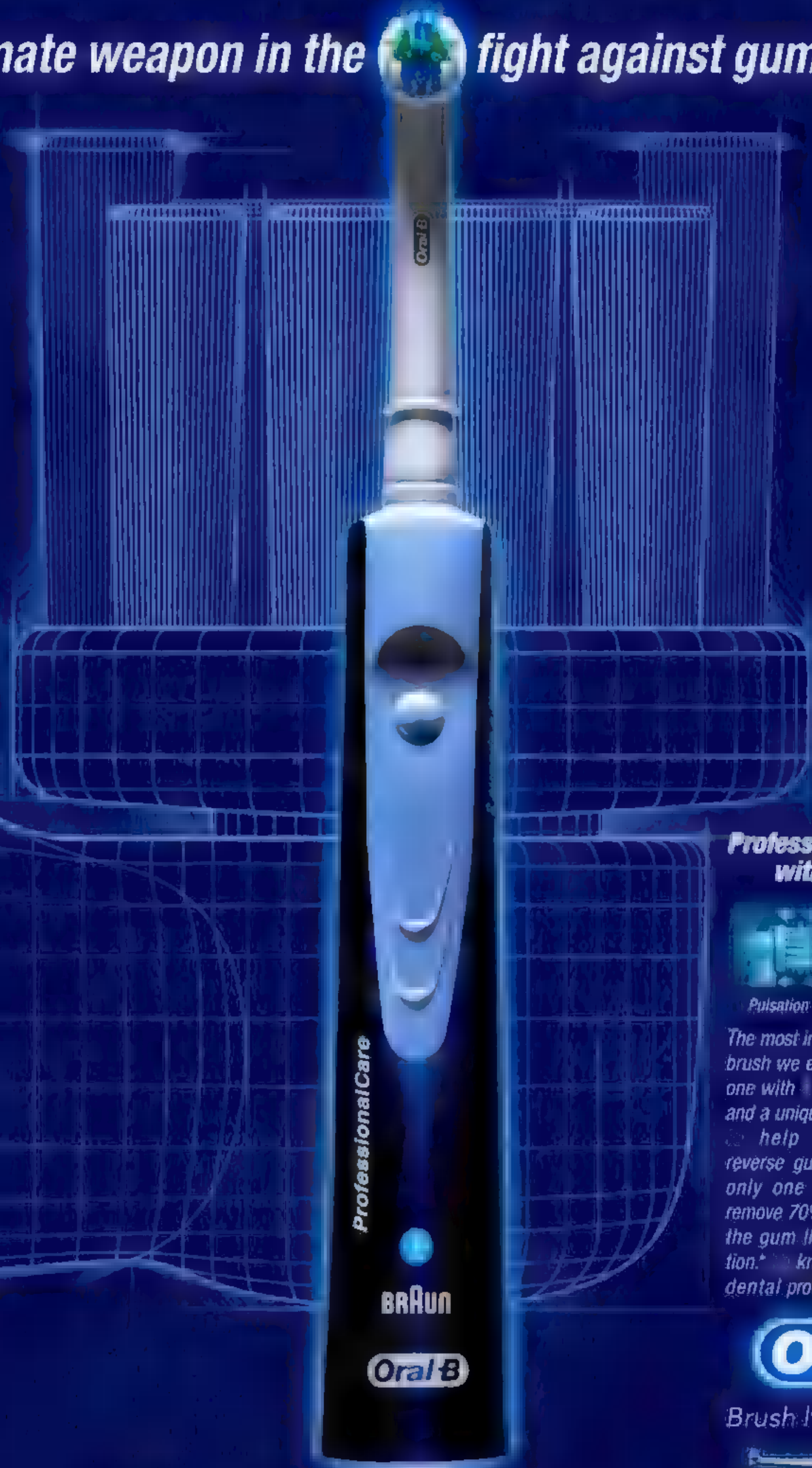


tangled up in the tools,” says Connie Palacioz, who originally worked on *Doc* in the '40s. “I was 18 when I began here, and I put most of the rivets in *Doc*'s cab section.” Now a ginger-haired woman of 78 and a volunteer in the restoration effort, Palacioz stands at a table energetically stripping the grime off small metal parts with steel wool.

Today a new riveter on the scene, a behemoth known as a Computer Numerical Controlled Machine, works up to ten times faster than humans. It comes with a kind of cockpit of its own, equipped with video and computer screens and an array of controls that a rangy man named Shawn Smith plays like a video game. Under the machine's stout blue arches lie the rounded panels of a 767 fuselage. As Smith punches buttons, a video screen shows an extreme close-up of tools drilling holes,

Prime mover of the area's economy, Boeing's plant is a major facility for one of the world's two commercial aviation giants. The other, Airbus, has opened an engineering office in downtown Wichita to tap the local labor pool.

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WICHITA, KANSAS

applying sealant, and driving in rivets far from his command post. He pushes more buttons, and a different size drill instantly reports for duty.

Being replaced by machines is one worry among many for Wichita's aviation workers. With the airline business hemorrhaging money since September 11, local aircraft plants have laid off about a quarter of their 45,000 employees. Relations between the company and labor unions have soured over the cutbacks, which some machinists blame on Boeing's outsourcing work to other companies and overseas.

One night after work, several Boeing employees seek solace in a watering hole called Charlie's, a storefront bar and grill appointed with pool tables and airplane murals. David Bruce, a heavy-equipment operator, sits at the bar nursing a vodka on the rocks and striking out with the numbers on a lotto monitor. "I love Boeing," he says. "At least I used to. Now you always worry about job security. It's one thing to out-source jobs to a local company. But they're sending work over to China for the cheap labor. I think it's un-American."

(When asked to comment the next day, a Boeing spokesman responds that some nationalized airlines, like China's, require that the planes they buy be partly built in their own country.)

The ups and downs come with the territory in a city so dependent on a single industry. Growing up in Wichita, I witnessed the elation when Boeing won a fat contract, and the dejection when it lost one to an out-of-state competitor. Now it's a new, global ball game, with Boeing's chief competition coming from France—Toulouse, to be exact, home of Airbus. Recent scandals, budget and technical problems, and millions of dollars in lost contracts in Boeing's space and defense division have weakened the company and increased local anxiety, though Wichita may remain unscathed by these troubles.

But not all the news is bleak. Boeing-Wichita does top secret weapons work for the U.S. military and performs periodic maintenance on *Air Force One*, antidotes to the mercurial private sector. The company is lengthening the 737-900 in response to Airbus's roomy model A321.

Such sophisticated airliners have forebears in the collection of vintage planes displayed at the Kansas Aviation Museum, built in the 1930s as the Wichita Municipal Airport. Before coast-to-coast nonstop jet travel, the airport was a major pit stop between the coasts, offering locals glimpses of celebrities. Fred Astaire once delighted a crowd by dancing in the atrium while his plane refueled. Charles Lindbergh made the terminal a stop on his initial airmail route. Over the museum entrance, a bas-relief sculpture of Lindbergh's *Spirit of St. Louis* flies above ocean waves.

At a condominium not far away, Beulah Barnes gets home every day around 4 p.m. She's 63, but her retirement date is now uncertain. Her son Brian—one of three sons who over the years have worked under the same roof with her—was laid off from his job as a sheet metal worker. "He just found out he's going to be the father of twin girls," says Beulah. "So I'll keep working and help him until he gets back on his feet." □



A furry stress-buster named Gabby greets Beulah when she gets home. More than 12,000 of her fellow aircraft workers in Wichita have been laid off since 9/11, a big blow even in a city accustomed to the ups and downs of a volatile industry.

WEBSITE EXCLUSIVE

Find more 67210 images along with field notes and resources at nationalgeographic.com/ngm/0312.

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Final Edit



PABLO CORRAL VEGA

TANGO

Lean Two

It's a signature move for Carlos Gavito: He stands casually, unmoving, hands at his sides. His dance partner, Mariana Dragone, leans into him, fully trusting, testing the limits of balance. "The simplicity of the style is the magic of it," says Dragone, who has been dancing with the popular Gavito—for pleasure, not professionally—since 1998. "There are moments of silence, of pauses, but the energy makes one feel reborn."

Though he didn't select the photo for the tango article on page 34—having to pare down a wealth of powerful images to just 13—illustrations editor Bert Fox was intrigued by the quiet intensity of this pose. "You expect tango to be hot, sweaty, with bodies entwined," he says. "This is none of those things. It's a lovely moment." But, he adds, "the intimacy of tango was captured better in other photos."

WEBSITE EXCLUSIVE

Cut it or keep it? Find out more about what tipped the balance for this photo—and zoom in on more images of the tango at nationalgeographic.com/ngm/0312.

“The clams were the only ones
that benefited from my arthritis.

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IMPORTANT INFORMATION ABOUT VIOXX.

People with allergic reactions, such as asthma, to aspirin or other arthritis medicines should not take VIOXX. In rare cases, serious stomach problems, such as bleeding, can occur without warning.

Tell your doctor if you have liver or kidney disease, or a history of angina, heart attack, or a blocked artery in your heart. VIOXX cannot take the place of aspirin for the prevention of heart attack or stroke. VIOXX should not be used by women in late pregnancy.

In clinical studies, commonly reported side effects included upper respiratory infection, diarrhea, nausea, and high blood pressure. Report any unusual symptoms to your doctor.

Please see the Patient Product Information for VIOXX on the next page for additional information that should be discussed with your doctor.

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You should read this information before you start taking VIOXX®. Also, read the leaflet each time you refill your prescription. In case any information has changed. This leaflet provides only a summary of certain information about VIOXX. Your doctor or pharmacist can give you an additional leaflet that is written for health professionals that contains more complete information. This leaflet does not take the place of careful discussions with your doctor. You and your doctor should discuss VIOXX when you start taking your medicine and at regular checkups.

What is VIOXX?

VIOXX is a nonsteroidal anti-inflammatory drug (NSAID) that is used to reduce pain and inflammation (swelling and soreness). VIOXX is available as a tablet or a liquid that you take by mouth.

VIOXX is a medicine for:

- relief of osteoarthritis (the arthritis caused by age-related "wear and tear" on bones and joints)
- relief of rheumatoid arthritis in adults
- management of acute pain in adults (like the short-term pain you can get after a dental or surgical operation)
- treatment of menstrual pain (pain during women's monthly periods).

Who should not take VIOXX?

Do not take VIOXX if you:

- have had an allergic reaction such as asthma attacks, hives, or swelling of the throat and face to aspirin or other NSAIDs (for example, ibuprofen and naproxen).
- have had an allergic reaction to rofecoxib, which is the active ingredient of VIOXX, or to any of its inactive ingredients. (See Inactive Ingredients at the end of this leaflet.)

What should I tell my doctor before and during treatment with VIOXX?

Tell your doctor if you are:

- pregnant or plan to become pregnant. VIOXX should not be used in late pregnancy because it may harm the fetus.
- breast-feeding or plan to breast-feed. It is not known whether VIOXX is passed through to human breast milk and what its effects could be on a nursing child.

Tell your doctor if you have:

- history of angina, heart attack or a blocked artery in your heart
- kidney disease
- liver disease
- heart failure
- high blood pressure
- had an allergic reaction to aspirin or other NSAIDs
- had a serious stomach problem in the past.

Tell your doctor about:

- any other medical problems or allergies you have now or have had.
- all medicines that you are taking or plan to take, even those you can get without a prescription.

Tell your doctor if you develop:

- serious stomach problems such as ulcer or bleeding symptoms (for instance, stomach burning or black stools, which are signs of possible stomach bleeding).
- unexplained weight gain or swelling of the feet and/or legs.
- skin rash or allergic reactions. If you have a severe allergic reaction, get medical help right away.

How should I take VIOXX?

VIOXX should be taken once a day. Your doctor will decide what dose of VIOXX you should take and how long you should take it. You may take VIOXX with or without food.

Can I take VIOXX with other medicines?

Tell your doctor about all of the other medicines you are taking or plan to take while you are on VIOXX, even other medicines that you can get without a prescription. Your doctor may want to check that your medicines are working properly together if you are taking other medicines such as:

- warfarin (a blood thinner)
- theophylline (a medicine used to treat asthma)
- rifampin (an antibiotic)
- ACE inhibitors (medicines used for high blood pressure and heart failure)
- lithium (a medicine used to treat a certain type of depression).

VIOXX cannot take the place of aspirin for prevention of heart attack or stroke. If you take both aspirin and VIOXX, you may have a greater chance of serious stomach problems than if you take VIOXX alone. If you are currently taking aspirin for prevention of heart attack or stroke, you should not discontinue taking aspirin without consulting your doctor.

What are the possible side effects of VIOXX?

Serious but rare side effects that have been reported in patients taking VIOXX and/or related medicines have included:

- Serious stomach problems, such as stomach and intestinal bleeding, can occur with or without warning symptoms. These problems, if severe, could lead to hospitalization or death. Although this happens rarely, you should watch for signs that you may have this serious side effect and tell your doctor right away.
- Heart attacks and similar serious events have been reported in patients taking VIOXX.
- Serious allergic reactions including swelling of the face, lips, tongue, and/or throat which may cause difficulty breathing or swallowing and wheezing occur rarely but may require treatment right away. Severe skin reactions have also been reported.
- Serious kidney problems occur rarely, including acute kidney failure and worsening of chronic kidney failure.
- Severe liver problems, including hepatitis, jaundice and liver failure, occur rarely in patients taking NSAIDs, including VIOXX. Tell your doctor if you develop symptoms of liver problems. These include nausea, tiredness, itching, tenderness in the right upper abdomen, and flu-like symptoms.

In addition, the following side effects have been reported: anxiety, blurred vision, colitis, confusion, decreased levels of sodium in the blood, depression, fluid in the lungs, hair loss, hallucinations, increased levels of potassium in the blood, insomnia, low blood cell counts, menstrual disorder, palpitations, pancreatitis, ringing in the ears, severe increase in blood pressure, tingling sensation, unusual headache with stiff neck (aseptic meningitis), vertigo, worsening of epilepsy.

More common, but less serious side effects reported with VIOXX have included the following:

Upper and/or lower respiratory infection and/or inflammation
Headache
Dizziness
Diarrhea
Nausea and/or vomiting
Heartburn, stomach pain and upset
Swelling of the legs and/or feet
High blood pressure
Back pain
Tiredness
Urinary tract infection.

These side effects were reported in at least 2% of osteoarthritis patients receiving daily doses of VIOXX 12.5 mg to 25 mg in clinical studies.

The side effects described above do not include all of the side effects reported with VIOXX. Do not rely on this leaflet alone for information about side effects. Your doctor or pharmacist can discuss with you a more complete list of side effects. Any time you have a medical problem you think may be related to VIOXX, talk to your doctor.

What else can I do to help manage my arthritis pain?

Talk to your doctor about:

- Exercise
- Controlling your weight
- Hot and cold treatments
- Using support devices.

What else should I know about VIOXX?

This leaflet provides a summary of certain information about VIOXX. If you have any questions or concerns about VIOXX, osteoarthritis, rheumatoid arthritis or pain, talk to your health professional. Your pharmacist can give you an additional leaflet that is written for health professionals.

Do not share VIOXX with anyone else; it was prescribed only for you. It should be taken only for the condition for which it was prescribed.

Keep VIOXX and all medicines out of the reach of children.

Inactive ingredients:

Oral suspension: citric acid (monohydrate), sodium citrate (dihydrate), sorbitol solution, strawberry flavor, xanthan gum, sodium methylparaben, sodium propylparaben.

Tablets: croscarmellose sodium, hydroxypropyl cellulose, lactose, magnesium stearate, microcrystalline cellulose, and yellow ferric oxide.

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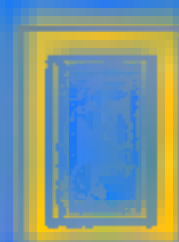
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JAPAN'S SAMURAI

Warrior for a Day

When the sword is mightier than the pen

He was supposed to wear rented peasant garb for the battle reenactment. Organizers of the samurai event in Yorii ask historical accuracy even of bystanders, and writer **Tom O'Neill** wanted to get close to the fighting. But photographer **Mike Yamashita** "told them I wanted to look like a shogun," says Tom, at right, who soon found himself strapped into armor so heavy he "felt like a parade float." Now a big target, Tom parried as best he could when another samurai made a lunge. "I just wish sword-fighting lessons had come with the suit," he says.



TANGO

Two Who Took to Tango

Before she ever wrote, **Alma Guillermoprieto** danced, studying under modern greats like Martha Graham and Merce Cunningham. Still, the tango that the journalist observed—and danced (above)—while in Argentina “was a completely different way of moving and of feeling” than she’d ever experienced before.

Alma’s award-winning reporting on Latin America has often centered, she says, on “very poor people in life-threatening situations, or situations of ultimate despair. And I guess you could say that about Argentina too. The Argentines are living a tragedy.” But tango has proved its power to overcome tragedy, if only for the duration of a song (sheet

music, right). “It felt wonderful,” Alma says of dancing the tango. “I was simply swept away.”

Photographer **Pablo Corral Vega** (bottom, at right) took tango lessons for almost a month. But one night, on the crowded dance floor of one of the most elegant tango clubs in Buenos Aires, he says he “forgot absolutely everything. I was completely paralyzed.” His partner whispered, “Either you move or we will create a traffic jam on the floor.” Pablo was so nervous he started laughing. “But no one ever laughs on the dance floor.”

One thing Pablo did learn about tango: Some Argentines preferred that he not document their passion for the dance, because it involved other passions they were trying to keep secret. “*Milongas* (tango sessions) can be full of lovers who are hiding,” he explains. “So the sessions can be tricky to photograph. I got kicked out of some.”



PABLO CORRAL VEGA (TOP), PABLO SENAREGA (ABOVE)

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MICHAEL MCGINNIS, NAVAIR, CHINA LAKE

WINGS OF CHANGE

Sky Writer

Even as a kid, **Mike Klesius** knew he wanted to fly jet fighters. He also knew he wasn't pilot material. "I had bad eyes and worse math skills," he says. Fortunately those problems didn't preclude a career in journalism—Mike's eventual path. In fact, journalism finally put him in the cockpit of an F/A-18 Super Hornet, touring California's skies at 600 miles an hour for this issue's aviation story. Mike, at right, came prepared with two days of survival training—and more. Beneath the writerly notepad strapped to the right leg of his flight suit an airsickness bag peeks from a knee pocket. He never did use it, but of this woozy walk after the flight with Marine pilot Maj. Mark "Jocko" Johnson, Mike says, "I think I'm asking, 'Where's the men's room?'"

WORLDWIDE

They may have been photographing flamingos, but this was no trip to a tropical paradise for brothers **Anup** and **Manoj Shah**. The lesser flamingos of East Africa's sunbaked Rift Valley flock to the region's alkaline soda lakes. Some of these slimy lakes have water caustic enough to irritate human skin; others bubble with burning thermal springs. The flamingos' legs have a tough protective skin, but our photographers had no such advantage. What to do? "I didn't go into the water at all," admits Anup. His vantage point "was always from the shore or from above, in ■ plane."

When writer **Cliff Tarp** spent ■ day on the job at the Wichita, Kansas, Boeing Aircraft plant,

it was like a homecoming. Cliff, at far right, with machinist Mack Terronez, Jr., grew up in Wichita, where Boeing was practically a family tradition: His sister was a parts dispatcher at the plant years ago, and his nephew worked there too. The GEOGRAPHIC staffer returned to his hometown to do a story on the biggest industry in zip code 67210: airplanes. Wichita's economy, Cliff says, "lives and dies" by the aviation business.

Cliff's favorite part of the Boeing plant was the one his guides would tell him the least about. "They call it the Black Hole," he says of the section where classified military work is done. When he saw a 747 "bristling with antennas," Cliff innocently

asked if it had been refitted as ■ tanker plane, to refuel fighter jets. "No," his guide said, "It's . . . something else."



FRED SOLIS

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Flashback



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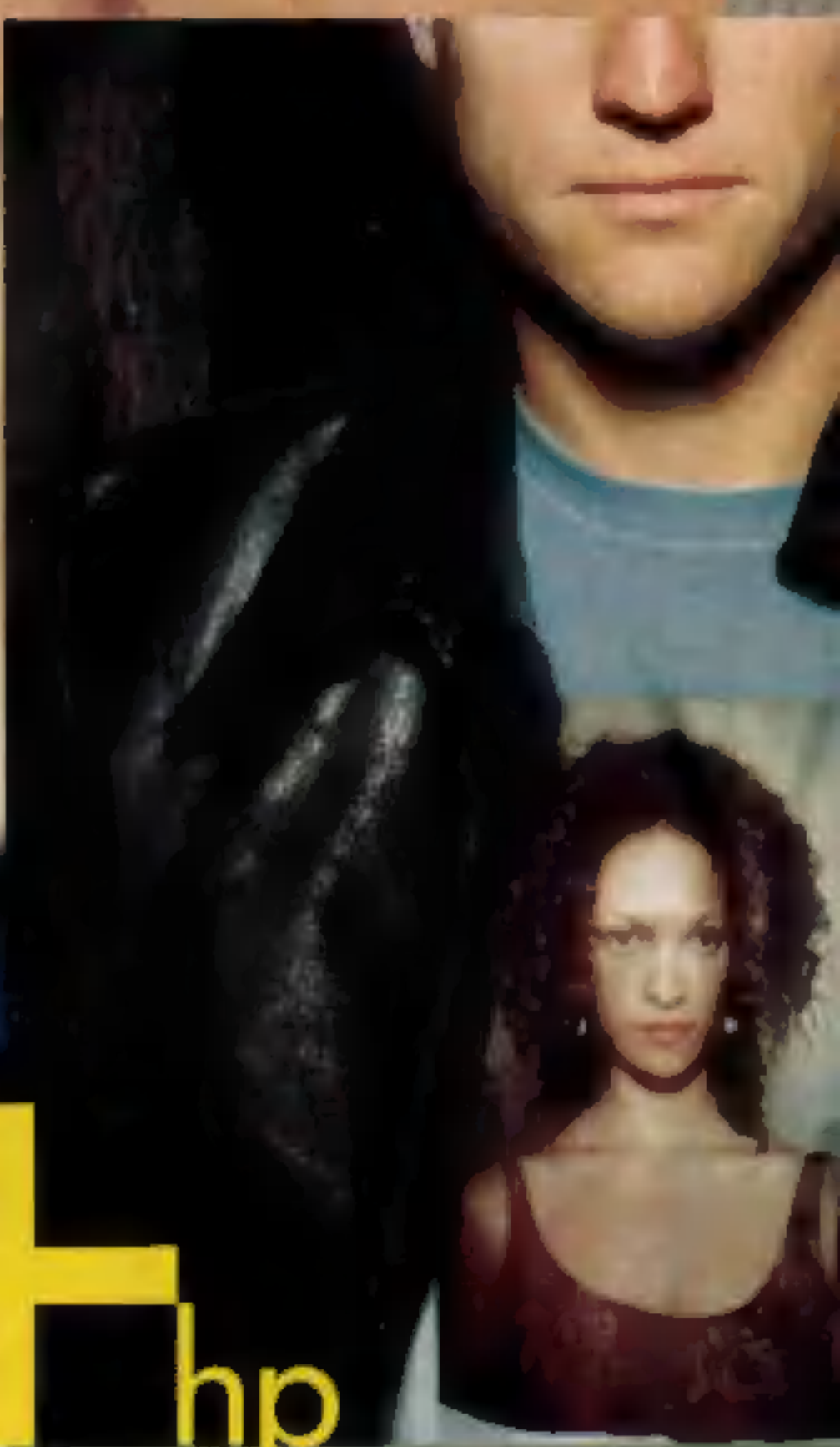
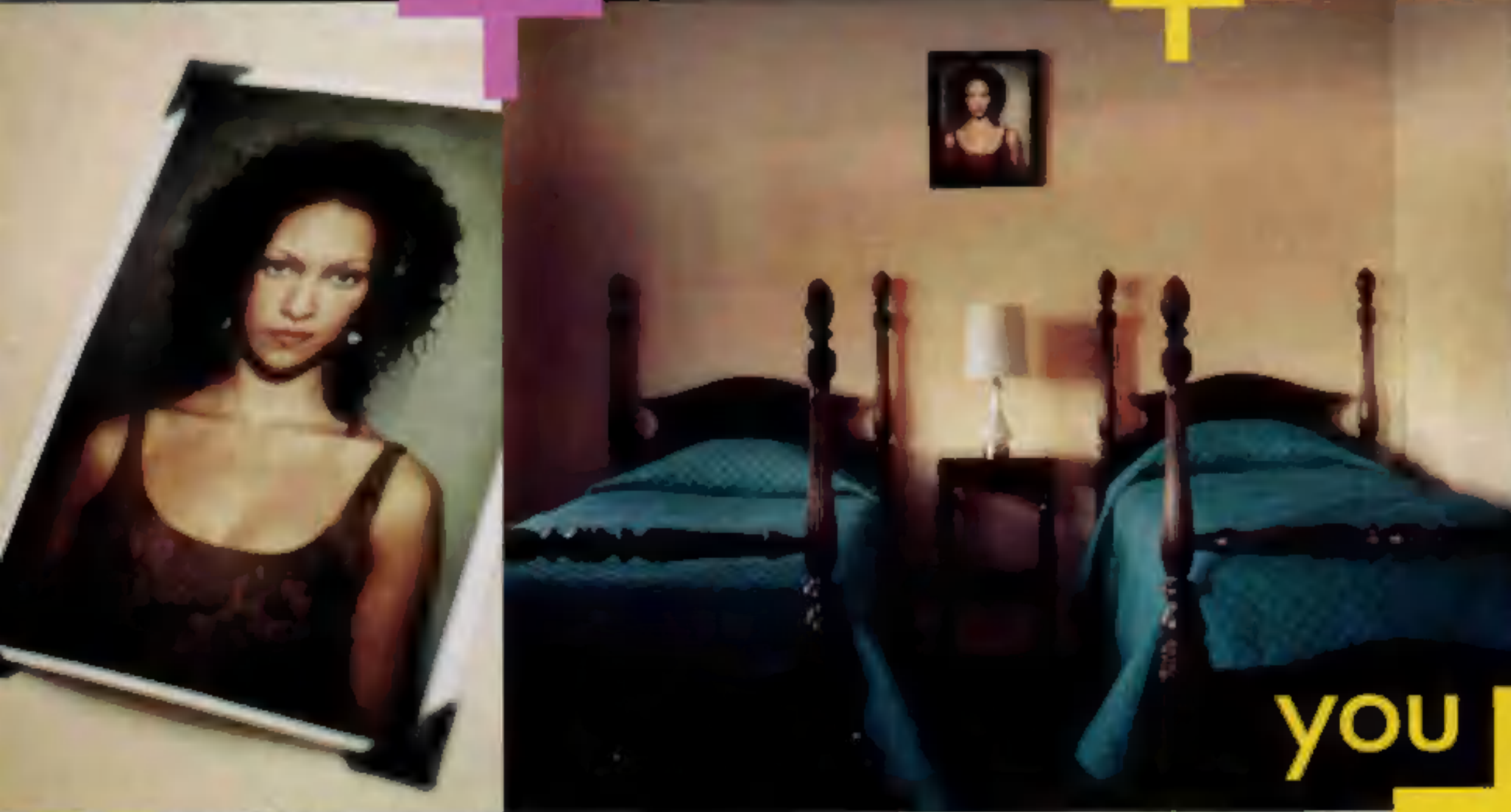
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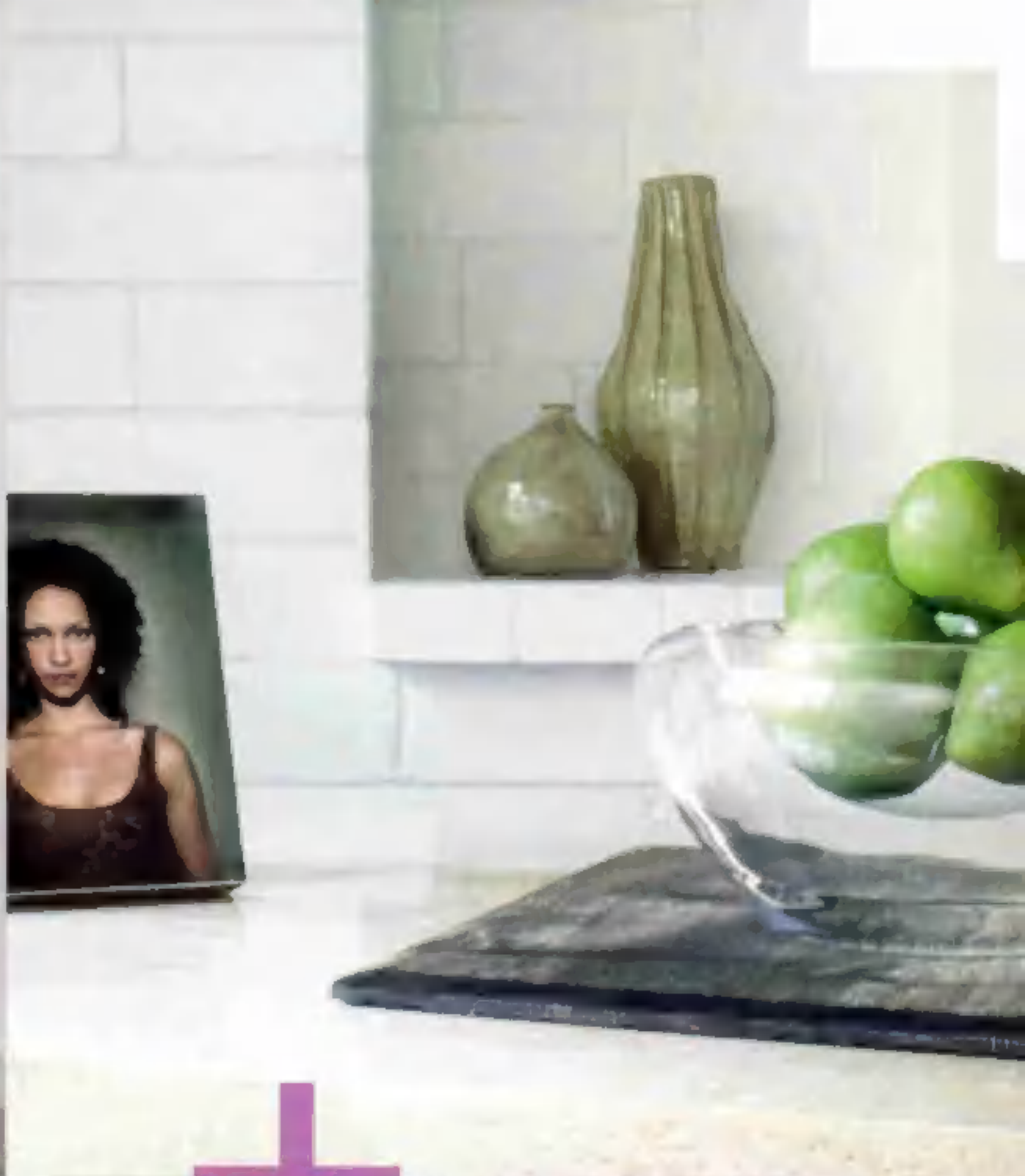
Soar Subject

When the ConvAirCar buzzed San Diego for more than an hour during a trial flight in November 1947, hopes rose as high as the hybrid craft itself. Would commuters soon be able to choose between highway and skyway? The 725-pound auto-plane prototype had a detachable fiberglass car body that people could drive like any other car, wrote F. Barrows Colton in the February 1948 *GEOGRAPHIC*, where this photo appeared. Like other vehicles, the flying kind could also run out of gas, which is what the ConvAirCar did on its third test flight. The pilot survived the crash. Plans for manufacturing the auto-plane did not.

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